

Founded January, 1903 by
PALMER H. LANGDON
1868-1935

METAL INDUSTRY

VOLUME 37

NOVEMBER, 1939

NUMBER 11

Publication Office:
116 John Street, New York



L. J. LANGDON
Publisher

THOMAS A. TRUMBOUR
Business Manager

DR. WALTER R. MEYER
Managing Editor

PALMER H. LANGDON
Assistant Editor

JOAN TRUMBOUR
Advertising Manager



PUBLISHED MONTHLY—Copyright 1939
by The Metal Industry Publishing Company,
Incorporated, 116 John St., New York,
N. Y. Entered February 25, 1903, at New
York, N. Y., as second class matter under
Act of Congress, March 3, 1897.

SUBSCRIPTION PRICES: United States
and Canada, \$2.00 Per Year; Foreign \$4.00.
Single copies, 20 CENTS. Please remit by
check or money order; cash should be regis-
tered.

ADVERTISING RATES on application.
Forms close the first of the month. Advertis-
ing copy should be mailed in time to reach
us on or before the 20th of the preceding
month.

METAL INDUSTRY reserves the right to
investigate all products offered for adver-
tisement, to refuse advertising considered
unsuitable and to edit advertising copy when
necessary.

CONTENTS

Editorial	497
Uses of Nickel Silver	498
Electroplating of Automobile Parts in the Soviet Union—By W. B. Stoddard, Jr.	500
Properties, Heat Treatment and Finishing of Stainless Steels—By E. F. Ingersoll	503
The Protection of Silver by the Electrolytic Deposition of Beryllia—By L. E. Price and G. J. Thomas	507
High Lead-Low Tin Alloys as Coating Materials—By Joseph B. Kushner ..	511
Anodic Coating of Aluminum—By Dr. Junius D. Edwards	513
Organic Finishing Supplement—Pages 537-556	

DEPARTMENTS

Shop Problems	520
Metallurgical Digest	523
Electroplating Digest	524
Post Scripts	525
New Equipment and Supplies	527
Manufacturers' Literature	532
Obituaries	534
Letters from our Readers	534
Associations and Societies	535
Personals	557
Verified Business Items	558
Supply Prices	562

METAL INDUSTRY articles are listed regularly in the Engineering Index and the
Industrial Arts Index.

The
Barbara Bates
**MANICURE
SETS**



The
LEA

METHOD... has much to do with giving these
articles an attractive finish at low cost

The Lea Method is used on the implements themselves and on parts of the box containing them. The implements, made of steel, are polished with Lea Compound (a patented type of greaseless buffing composition) in preparation for gold plating. All brass parts, including the box frame and the top of the buffer, are cut down with Learok (the buffing bar with "no free grease").

Here's an excellent example of a manu-

facturer making use of these two clean, fast-working, special compositions for producing the desired finish on an article. Each serves a useful purpose. Each fits into the LEA METHOD of Finishing which lowers costs by reducing the number of operations.



There is no limit to the versatility of the LEA METHOD of FINISHING. It has many applications.

THE LEA MANUFACTURING CO.

Waterbury, Conn.

Specialists in the Production of Clean-Working Buffing and Polishing Compounds

METAL INDUSTRY

VOL. 37, NO. 11

FABRICATION · ASSEMBLING · PLATING · FINISHING

NOVEMBER, 1939

A Job Well Done

In an editorial in the October issue of Metal Industry, mention was made of the excellent quality of the Annual Proceedings of the A. E. S. meeting held at Asbury Park.

Since writing the editorial, we have learned that no small measure of the credit for the workmanlike task is due Phil Ritzenthaler and Michael Doyle of the Milwaukee branch who spent many hours in editing and proof reading the manuscripts and discussions to insure complete accuracy.

Much credit is also due to Miss Florence Marquardt for her accurate reporting and extensive efforts to insure accuracy particularly of discussions, and to Executive Secretary W. J. R. Kennedy for his active cooperation and helpful advice.

We join with the Society in offering our sincere congratulations to these workers and any others who have served in making the 1939 Proceedings a volume of both beauty and utility.

Problems for Research

The response to our recent editorial entitled "More Research on Electrodeposition Needed" has been pleasing.

Many inquiries have been received asking for specific problems which could be made the subject of research.

Research need not necessarily mean the study of complex ternary alloys inasmuch as there is much work still to be done on the everyday problems and solutions. The explanation for the effects of ammonia in brass plating solutions, for example, was published by L. C. Pan only a few years ago in spite of the fact that ammonia has been used in brass plating solutions to control color almost since the discovery of the cyanide brass plating solution.

Let us now consider some specific problems which may be subjects for either short or extended researches:

THEORETICAL PROBLEMS

1. Are the pronounced effects of metallic impurities on electrodeposits due to their deposition as metal

per se, as basic salts, oxides or other compounds, or are they due to electrochemical effects such as polarization or overvoltage changes?

2. Why is it that nickel cannot be deposited from cyanide solutions which contain no metals whereas it will deposit with copper from a cyanide solution?

3. Is brightness purely a function of grain size in metals? (Frankly, the editor is of the opinion that a critical grain size has to be reached for brightness but this critical value is dependent on the orientation of the minute crystals or crystallites and the presence of co-deposited material. Thus in cyanide copper solutions, the grain size may be sufficiently small for brightness but the dullness observed is a macroscopic effect due to minute nodularization because of co-discharged hydrogen or basic matter. The function of "brighteners" may not be to reduce the grain size necessarily but to promote layering and prevent nodularization.)

4. What are the effects of anions on the character of the deposit? (See work of Hothersall and co-workers on the effects of sodium and potassium in nickel plating solutions.)

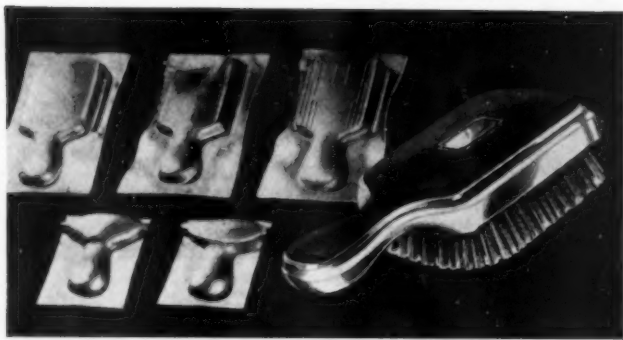
5. What is the explanation for the periodic phenomena at the cathode evidenced by banded deposits and periodic polarization changes?

6. Why is it possible to obtain electrodeposited alloys such as silver and cadmium with phases above or below those predicted by the composition and the equilibrium diagram?

7. What is the explanation for the isolated clusters of zinc obtained by depositing zinc at low current densities?

The list of problems on theoretical aspects of electrodeposition could be continued almost indefinitely. Problems of a practical nature will be considered at length in the December issue.

In closing we would like to point out that there are many men in the United States such as Dr. William Blum, George B. Hogaboom and Prof. E. A. Baker who have given and are willing to give advice on subjects for research. Let us hope that a renaissance will take place in electrodeposition research.



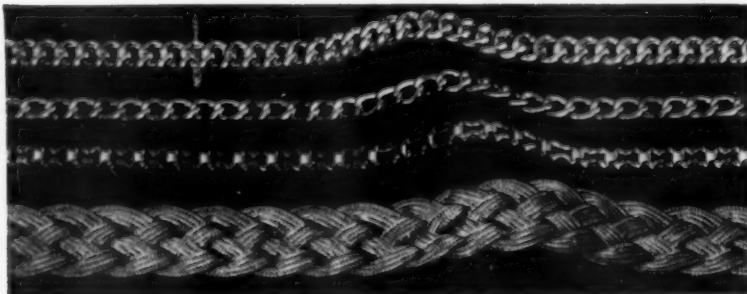
Above—Sequence of steps in making the nickel silver handle and back of a brush.



Above—Miscellaneous jewelry products manufactured from a nickel silver alloy.



Left — Beautiful silver plated tray and pitcher. The base metal for these and similar wares is nickel silver.



Above—Different style link bracelets made of nickel silver wire by the Universal Chain Company. This jewelry may be plated with gold or silver.



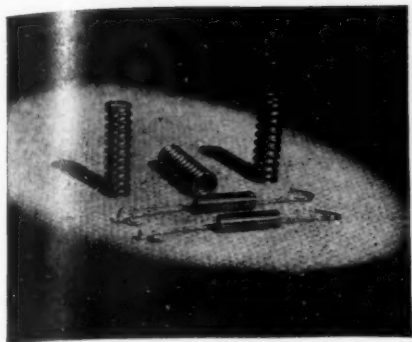
Right—The baton of this attractive drum majorette is nickel silver as are many musical instruments in the band.

Uses of NICKELS

Nickel silver is a highly malleable and ductile alloy of copper that is finding increasing employment in a wide diversity of applications. It has an attractive color, beautiful lustre, durability and high resistance to corrosion. Nickel silver can be readily worked and is widely used for decorative and utilitarian purposes. It is used as a base metal for silver plated hollow ware and flat ware, for cutlery, surgical and orthopedic appliances, drafting instruments and slide fasteners. Screw machine products, keys, fishing reels, watch cases, jewelry, nameplates, musical instruments and optical goods are also made from this versatile alloy. It is also used for marine hardware and automobile trim, for architectural trim, furniture, dairy equipment and condenser tubes.

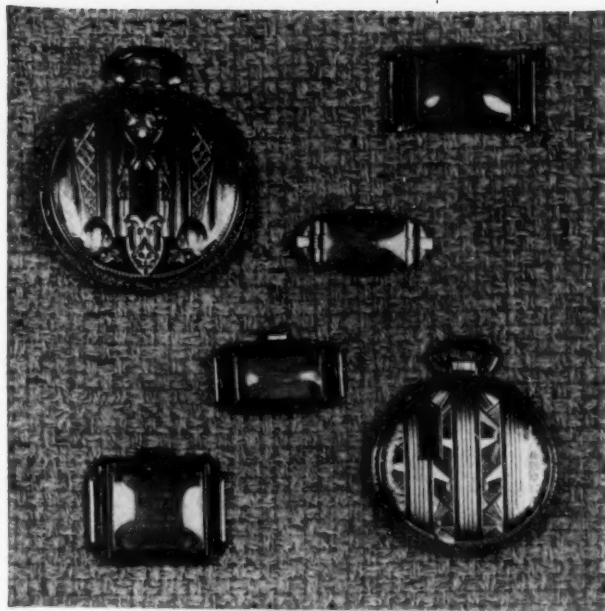
Such a wide range of applications is obtained by varying the proportions of copper, nickel and zinc upon which the physical and chemical properties, the color and the workability of the several different alloys depend. The ratio of metals and the temper of the alloy is dependent on the specific requirements of the finished product. Nickel silver contains from 55 to 75 per cent copper, five to 30 per cent nickel while the balance is zinc. The corrosion resistance of nickel silver increases as the percentage of copper and nickel.

This article and illustrations on the use of nickel silver have been kindly furnished by the Copper & Brass Research Association.



Left — Corrosion resistant springs made from nickel silver wire by the Wallace Barnes Co. are available in many sizes and tempers.

is increased. The most popular alloy of nickel silver contains 18 per cent nickel, 55 to 65 per cent copper and the balance zinc. If the resultant alloy is to be used for purposes requiring high resistance to corrosion or fatigue, or if there is to be quite a bit of fabricating, the higher copper content is preferable. However, if the product is to be made by simple operations and the corrosion problem will not be severe, the higher zinc content will permit the development of spring qualities and electrical resistance properties. Springs of nickel silver can be cold rolled to obtain a tensile strength of 110,000 pounds per square inch with a Brinell hardness of 160.



Courtesy: Keystone Watch Case Corp.

Another interesting employment of nickel silver is in the manufacture of cases for men's and women's watches which are then either gold or silver plated.

NICKEL SILVER expand to many new fields

Nickel silver is supplied in the form of sheets, rolls, strips, wire, rods, tubes and many special shapes and contains the composition, grain size, temper and gauge specified by the requirements.

Below—Exhibiting the wide range of application and the great versatility of this alloy, nickel silver is shown here employed in the construction of modern furniture.



Electroplating of Automobile Parts

In the Soviet Union

By W. B. Stoddard, Jr.

Russia has made rapid progress in technological developments on electroplating and the author describes the immense Stalin Automobile Factory where over 45,000 people are employed. Mr. Stoddard graduated from Colorado University in 1929 as a chemist and worked for five years on plating research in an American research organization. He went to Russia in 1936 as Chief Technical Consultant on research and production for the Stalin Automobile Factory and returned to America a few days before the war started. The lack of illustrations is due to the Russian ban on taking photographs out of the country. —Ed.

With Soviet Russia so much in the news nowadays, it may be of interest to learn, in a general way, what is being done in the field of electroplating in the Soviet Union.

Soviet Thickness Specifications

Quality products made of metals which will corrode if exposed to the atmosphere require some sort of real protective coating. Automobile parts, most of which are made of base metals such as iron or steel, or zinc base die castings, require protection from atmospheric corrosion, and consequently one has to look first at the plating specifications for steel and zinc base die castings to decide whether or not a sufficient thickness of metal is being applied to produce an article which will stand up. Secondly, one must inquire into the various technological processes to gain some idea of the skill and speed with which these articles are produced.

In the Soviet Union at the automobile factory in the name of Stalin, whose trucks, busses, and passenger cars carry the trade name, ZIS, the following are the specifications for the thickness of copper, nickel, and chromium required on articles where decorative appearance and corrosion resistance are essential:

Metal	Thickness	
	in inches	in millimeters
Copper	0.0008	0.020
Nickel	0.0006	0.015
Chromium	0.00004	0.001



W. B. Stoddard, Jr.

It will be seen that the requirements for copper thickness are in general greater than those used in this country, while the nickel specifications are approximately one half those demanded by our latest practice. Nevertheless, the total thick-

ness of this composite coating is approximately the same as that demanded in this country and under the severe corrosive action of a salt spray cabinet, articles when prepared according to these specifications, will stand more than one hundred hours before breakdown occurs.

Zinc and cadmium plating for protection against corrosion without regard to appearance is carefully controlled for minimum thickness. Protection against atmospheric corrosion according to Russian standards demands 0.0005" of zinc or cadmium.

Inspection

After each polishing operation, the articles are inspected and rejected if they do not have the proper finish. After the final polishing operation before plating, the articles are carefully inspected and then plated. After each plating operation, an inspection takes place both before and after polishing. Frequent checks are made on the thickness of metal deposited, and recently an adaptation of one of the older thickness testing methods has been introduced which allows this important procedure to be carried out rapidly and accurately with a minimum investment in equipment. (It is hoped shortly to devote a special article to the description of this thickness testing method).

The final inspection is based principally upon appearance and seems to the author to be unusually rigid. Automobile bumpers are inspected for surface defects as if they were watch cases. From the thickness specifications and inspection details given above, it will be seen that the plated parts on the Soviet automobiles, trucks, and busses are better than many people would believe.

Plating Equipment

The principal plating shop in this factory has for its basic production three automatic plating machines. One of these machines is for copper, one for nickel, and one for chromium. The copper and nickel automatics are American made side-arm machines, while a straight line automatic machine is used for chromium plating. These automatic machines are supplemented by a large array of still tanks. This shop consumes about 100,000 amperes current which is obtained from a battery of six and twelve volt generators. In the generator room, one can see Chandeyson's, Hanson-Van Winkle-Munning's, Electric Product's, and numberless Soviet generators, the latter running from 500 to 4000 amperes in capacity.

Filtration of the solutions is done by means of filter presses. Experiments are being carried out on Soviet filters of the industrial type. The nickel solutions are heated with duriron heat exchangers, while duriron pumps, Soviet and American diaphragm pumps are used for solution circulation. A great deal of duriron piping is in evidence.

The polishing room is separated from the plating room although the shop conveyor system runs in and out of the polishing room to facilitate the transfer of parts with a minimum loss of labor and time. This conveyor system has been designed so as to include in its route the greatest number of operations which follow one another in sequence. Ventilating equipment in both the plating shop and the polishing room is designed according to modern ideas. The ventilation between the polishing shop and the plating room is so arranged as to give a very slight difference in pressure where the greater pressure is maintained in the plating rooms to prevent polishing dirt from entering. The ventilation in the polishing room itself is carried from the lathes downward through the floor. Using this arrangement there is a surprising lack of visible piping, and consequently better overall illumination. This type of ventilation is also used in the plating room. American, Russian, and German polishing lathes are in use, however, the Russian machines are in the majority. Practically all of the buffs, glue wheels, emery, and

polishing compositions originate within the Soviet Union. There is also in evidence some automatic polishing equipment, most of which was supplied by an American company.

In the plating room, tanks have been provided for all the different types of plating likely to be required. Considerable space has been allotted for experimental work on a semi-production scale. Most of the rubber lined tanks have been produced within the Soviet Union. This shop is provided with large rubber lined storage tanks in the basement so that solutions may be transferred from the production tanks should the necessity arise. Transferral of the solutions from the basement back to the plating tanks is accomplished by means of air pressure.

Personnel

This plating shop is controlled by a head foreman who has several assistants. Technological control is done by a different department, which department controls the technology of the entire factory. As may be expected, this technological department is staffed with technically trained people, that is, chemists, chemical engineers, mechanical engineers, metallurgists, etc. This technological department has a library and maintains a large staff of translators. The control personnel of the plating shop has also received an advanced technical education. The workers in the shop are young people, most of them being between the ages of eighteen and twenty five and about fifty percent of them are women. The working day is seven hours while every sixth day is free. Practically all of the workers have received the equivalent of a high school education and are required to study a certain number of months each year. These study courses are directly related to the work which they are doing. For example, courses are given in elementary chemistry, physics, and electroplating. Quite often people who show the ability and the desire to go ahead with their education are sent to the universities with all expenses paid.

Supplementary Equipment

Within the same building which houses the plating and polishing

rooms, there are many separate departments. Included in these departments are the pickling and bright dipping rooms, a welding shop, a stripping shop, a shop for motor and generator repair, a shop for rack building, and a specially laid out room for coating racks. Several rack coating materials are in various stages of development.

Plating Solutions

All of the common metals are deposited in this shop. These include copper, nickel, chromium, zinc, cadmium, tin, silver, and lead. As yet bright nickel has not come into large production chiefly because of lack of proper equipment. High speed copper plating with finishes ranging from semi-bright to bright is obtained from a solution developed by the author while in the Soviet Union. Zinc plating is done both in acid and in cyanide solutions while one will find the usual cyanide cadmium solution in operation there. The zinc and cadmium solutions are operated in conjunction with addition agents to produce a better appearance of the deposit. As may be imagined, from the thickness of copper required, there is a considerable volume of acid copper plating solution in evidence. For the most part, acid copper solutions are operated without addition agents. In general, it may be said that, with the exception of the high speed copper cyanide plating solution, there have been no extreme departures in plating solutions in the Soviet Union, although a large amount of money is now being spent annually for research along these lines. Anodizing and rust proofing are more and more being utilized for corrosion or abrasion resistance.

In the stripping department one will find all of the usual stripping solutions and in addition, a stripping process has been developed there for the removal of copper from zinc base die castings. This process will take off all of the copper, even from the deepest recesses, without affecting the surface of the die casting.

Solution Control

Each plating shop in this factory has a separate laboratory where control analyses are run on all solutions as often as is necessary. Solution correction, based upon the results of

the control analyses, may be done as often as five times per week.

Zinc and Cadmium Plating of Small Parts

The plating of small parts with zinc is accomplished in a separate shop by means of two automatic barrel plating machines which were furnished by an American company. One of these automatics is used in conjunction with the cyanide zinc solution, and the other machine utilizes an acid zinc solution using a special brightener. Neither of these machines are operating up to full efficiency although steady progress is being made in learning how to increase operating efficiency. Besides these two automatics, there is a great deal of zinc plating done in still tanks where the work is racked or wired. Cadmium plating is done in still tanks.

In this same shop there are several large tanks in which details to be heat treated are stopped off with copper from cyanide copper plating solutions. The copper plating process is carried to zero porosity. A great deal of research work has been done in the research laboratory, on the subject of the causes of porosity in copper deposited from cyanide solutions.

Electrolytic Pickling

The principal use of electrolytic pickling in this factory is for the removal of fire scale after heat treating processes. For this purpose there are several large full automatic conveyors, the pickling process taking place in several stages. These conveyors were designed and built in the Soviet Union.

Research

More and more time and money are being spent upon research in all fields of science in the Soviet Union. This statement applies not only to the fields of pure academic research but also research in conjunction with production. In this factory practically all the different departments maintain research laboratories whose business it is to simplify or to increase the efficiency of production processes. The research laboratory for metal plating is staffed by six

people who are either chemists or chemical engineers. All of these people are recent graduates and make up a part of the technical control staff for electroplating. All together there are about twenty technologists connected with the plating processes, exclusive of the control-laboratory chemists. Every year or so a certain portion of the research staff is transferred to production work while their places are taken by people who have been supervising production. The research laboratory is constantly at work on problems directly connected with plating, such as, for example, high speed copper, bright nickel, bright zinc, stripping processes, thickness determination problems, cleaning, porosity, etc.

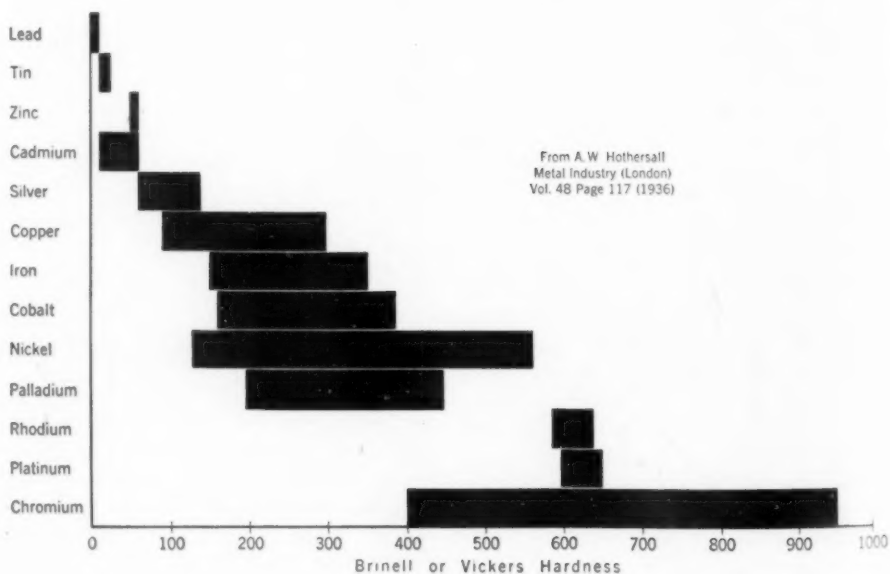
This laboratory has access at all times to the central chemical laboratory, the metallurgical laboratories, the corrosion testing laboratory, the mechanical testing laboratory and machine shop, the spectographic laboratory, and the photographic laboratory. Translations from almost any language are available through a bureau of technical information. As has been mentioned before, the fac-

tory maintains a good technical library. Through this library one can obtain technical books and magazines from many of the libraries in Moscow.

Chemicals

With the exception of a few small items, all of the chemicals used in electroplating are supplied from within the Soviet Union. Within a period of three years, the quality of these materials has improved to a surprising extent, nevertheless there is still much room for improvement and consequently much work is being done along these lines. In the past, it has been necessary to include many unnecessary steps in electroplating simply because the materials at hand contained too large a percentage of impurities. As time goes on, trouble from this point is diminishing at a rapid rate. For example Soviet nickel anodes with ten percent iron and much copper and zinc were not unusual two years ago, while at the present time nickel anodes are produced there which run better than 99% nickel plus cobalt.

Hardness of Electrodeposited Metals



Electroplated metals have surprisingly great hardness values, and in some cases the hardness of electroplated metal exceeds that possible by either mechanical or alloying treatment. The hardness of electroplated platinum is particularly surprising in view of the softness of the normally used platinum.

Properties, Heat Treatment and Finishing of Stainless Steels

By E. F. Ingersoll

A review of the composition of stainless steels is given. A discussion of the effects of alloying elements introduces a consideration of the heat treatment, pickling, passivation and also working qualities of stainless steels. The author also discusses the spinning, shearing, punching, welding, soldering and finishing of stainless steels. A list of finishes of commercial sheet is given.—Ed.

Introduction

The relatively recent introduction of a group of chromium and chromium-nickel iron alloys commonly known as stainless steels has given manufacturers and fabricators some definite control over the corrosion of iron and steel products without recourse to plated films.

Stainless steel development began in 1913 when Harry Brearley, an English metallurgist, found that chromium added to iron produced an alloy resistant to ordinary oxidation, or rust. The corrosion resistant properties of chromium in combination with iron and steel comes from the formation of a protective film in the presence of oxygen.

The film is stable, extremely adherent, and so thin that it cannot be seen even under very high magnifications. Re-formation of this film, when broken, is instantaneous thus insuring its protective function permanently. At high temperature, the film thickens, loses its transparency and forms a tight scale that endows the alloy with good heat resisting properties.

Experiments conducted by Benno Straus and his associates at the German Krupp Works during the World War showed that the addition of nickel to high chromium steels gave a greatly improved alloy. Nickel improves the ductility and working properties of these alloys, rendering them more suitable for many difficult forming operations, and at the same time, it gives greater resistance to many types of corrosion. The ferritic nature of straight chromium alloys is changed by the addition of nickel by rendering the metal austenitic (non-magnetic) at atmospheric temperature. In addition to being non-magnetic, the austenitic alloys are quite ductile and non-hardenable by heat treatment, although their strength and hardness can be increased by cold working. In short, the principal advantages of stainless steel include an attractive chromium-like appearance, high tensile strength, great heat resistance, resistance to many forms of corrosion, permanently smooth surface, ease of cleaning and uniform consistency.

In face of the increasing demand for products fabri-

cated from stainless steels, a wider understanding of methods of procedure for fabricating and finishing would not be out of place.

The following suggestions, which are based upon information submitted by several supply companies and a study of methods employed in various plants are offered in the hope that they may be of some value to the reader. There are no definite sets of standards or rules that can be applied for use with each of the many metal compositions, but almost any one of the alloys can be economically fabricated and finished.

In addition to the advantages of chromium and nickel in these alloys, the following alloying elements are of importance for these reasons:

Molybdenum increases the tensile and creep strengths at elevated temperatures.

Tungsten increases the physical strength at elevated temperatures.

Aluminum and *copper* together and in percentages of aluminum 0.5 — 1.0%, copper 0.5 — 1.0%, increase, respectively, the alloy's resistance to oxidation at higher temperatures and to acid corrosion.

Columbium renders the alloys less susceptible to air hardening.

Various modifications of the above-mentioned properties are obtainable for special applications.

Heat Treatment

Of these several compositions of alloy steels, the alloys that are heat treated are of the straight chromium type, since the addition of nickel renders these alloys non-hardenable and austenitic. One of the most widely used stainless alloys for its hardening properties is the 410 type. Since the exact composition of this alloy varies slightly, each supplier having his own particular analysis and limitations, the exact temperatures for heat treatment should be taken up with the company supplying the metal. Of the chromium-nickel grades of stainless steels, type 302, commonly known as 18-8 seem to be in quite wide use. The usual heating (in a muffle or semi-muffle type furnace) is to 1800°-2000° F., depending upon the gauge, and air cooling rapidly or quenching in water. The metal must be cooled rapidly and it is claimed that no harm will come from the most drastic quench.

The time at annealing temperatures for sheets, plate and strip is generally specified as about three to five minutes depending on the gauge. This treatment dissolves carbides and reforms any austenite which may have been broken down at intermediate working temperatures. It also

conditions the metal for greater resistance to corrosion and endows it with maximum ductility. After quenching or rapid air cooling of the sections or small parts, the metal should be pickled before additional drawing operations take place to prevent die damage, or if the metal has been shaped to desired forms and heat treated for hardness, the scale must be removed before finishing operations are started.

Scale Removal

The formation of scale may be minimized by establishing conditions in the heat treatment which will favor prevention of heavy scale. This can be accomplished by introducing a neutral or slightly reducing atmosphere in the furnace chamber. When scale is formed, the following procedures have been found to be advantageous.

The pickling procedures and formulae are numerous and are very slow in action when only sulphuric or hydrochloric acid are used.

The processes, however, may be speeded up by small additions of nitric acid. This addition also tends to produce a bright pickled surface. The following formulae and procedures are typical of those in common use:

No. I.

Water	14 parts
Commercial hydrochloric acid	5 "
Commercial nitric acid	1 part

No. II.

Water	9 parts
Commercial sulphuric acid	1 part
Commercial hydrochloric acid	1 "
Commercial nitric acid	1 "

The solutions may be used from room temperature up to 140° F. depending upon the condition and type of metal being treated. Inhibitors should be used in formulae of the above type.

Small stainless steel products that have been heat treated for hardness and have developed a heavy scale, have been satisfactorily pickled by the following sequence of operations.

1. Softening solution.

Water	10 gallons
Commercial hydrochloric acid	1 gallon
Inhibitor*	

* The amount will usually be specified by the dealer supplying the material.

Immerse work from 5 to 15 minutes at 150° F., to soften scale.

2. Thorough rinse.

3. Pickling solution.

Water	10	gallons
Nitric acid (40° Be)	0.5	gallon
Hydrofluoric acid (60%)	0.125	"
Time	5 to 15 min.	
Temperature	Room	

If scale is not thoroughly removed, repeat the operations.

The exact composition of a pickling solution for any specific alloy is best determined by experiments in which varied concentrations of the different ingredients are tried singly, until the desired result is secured.

Electrolytic pickling is also being used on an increasing scale in many plants. Phosphoric acid, ranging in strength

up to 15% by volume is being used for stainless steel. The work is either cathodic or anodic and current densities are adjusted to produce the desired result.

Passivating

This treatment which renders the surface of the metal passive removes all the foreign metallic particles that have become embedded in the surface during fabrication, and prevents them from serving as starting points for local electrochemical attack.

Passivating solution:

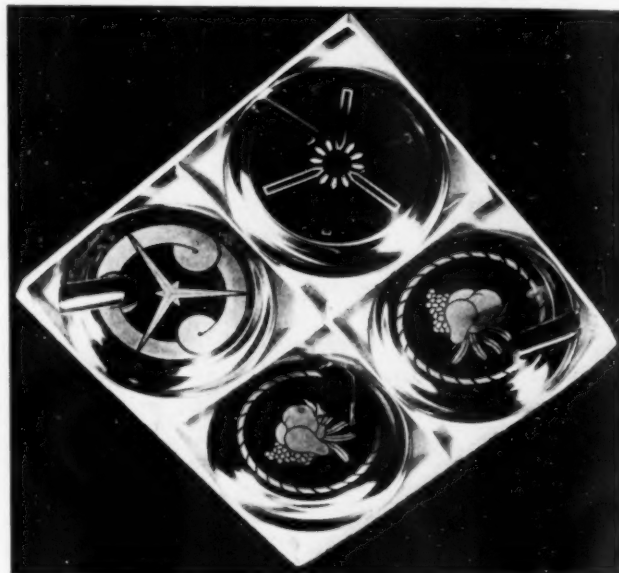
Nitric acid (38° Be) 10% to 20% by volume.

Solution heated from 130° to 150° F., for from 10 to 30 minutes.

After passivating, the metal should be thoroughly rinsed in hot water.

Forming and Deep Drawing

* While the straight chromium grades of alloy steels approach mild steel in ductility, the 18-8 and 19-9 grades have ductility that is remarkable in comparison. They



Ash trays of stainless steel with special finishes.

have greater strength than mild steel and work harden more rapidly therefore requiring more power in drawing and forming operations. When the equipment being used is originally intended for use with ordinary steel, greater care and slower speeds are advisable. The dies used should preferably be made from the non-deforming grades of deep hardening alloy tool steels such as the high carbon, high chromium types. Special bronzes may also be used for draw rings to minimize scoring and metal pick-up. In die set-ups, allowance should be made for double to triple the spring back of mild steel. Clearances of about 0.007" will be enough in most cases.

In designing dies, radii should be as large as possible allowing the material to flow into the die easily with minimum tendency to buckle. Blanks should be large enough to prevent excessive ironing out beneath the dies. Excessive ironing may result in breakage when attempting to secure cup depth, particularly in multiple operations draws, due to the work hardening properties of stainless alloys.

Proper lubricants are necessary but must be completely removed from the material before annealing when intermediate anneals are required. If this operation is excluded, decomposition of the lubricant might impair the metal by carburization. The most widely recommended lubricants are the water-soluble compounds, since they are easily removed. However, the following lubricants may be employed with equal effectiveness: White lead thinned to consistency of 600W engine oil or a mixture of linseed oil and sulphur.

Spinning

Proper allowance must be made for rapid hardening when spinning 18-8 due to its work hardening properties, while considerable more power is required than in working the softer metals. The tools used should be of relatively large radius and work done at speeds about one-fourth to one-half that used on copper. If successive anneals are made, the same precautions as mentioned under deep drawing should be observed.



Stainless steel equipment and trim is being widely used for restaurants and other food dispensing places.

Shearing and Punching

While most 18-8 alloys are quite ductile they do not break off after a portion has been cut. Consequently it must be cut clear through, requiring a close fit of punches and shear blades. These tools should be kept sharp by frequent grinding. Any play in the equipment that permits deforming of the metal ahead of the shear blades or punches, results in work hardening of the stainless steel, thus requiring more power for the operations. The straight chromium alloys, especially heavy plates, may require hot working.

Welding

Since the chromium-nickel grades of stainless steel are generally non-hardenable by heat treatment, welds of the same composition have no capacity for hardening. When the electric arc method is employed, the use of a coated electrode approximately equal to or slightly larger than the thickness of the stock being welded, is generally used. Ordinarily the work should be negative and the electrode

positive. Current should be increased with electrode diameter. About 35 volts, open circuit with 60 to 65 amperes is usually considered satisfactory for a 3/32" rod. The alloy content of the rod should be slightly greater than the metal being welded. This is to replace the loss of some of the alloying elements which usually takes place. No carbonaceous material should be contained in the flux coating the electrode.

Electric resistance welding is thought by many to be the most satisfactory method of welding stainless steel. Since it leaves no welding bead, a saving in time is effected. Strong electrode pressure is needed to produce a good metal-to-metal contact. Alloy steels of the stainless type have about six to eight times the electrical resistance of mild steel and about one-half the heat conductivity. Correct timing helps to insure strong uniform welds.

Electric welding is considered more satisfactory because of the danger of carbon pick-up from the gas flame, however, gas welding is said to be suitable for light gauges where it will not impart excess heat to the metal. To pre-

vent buckling, it is advisable to fasten the stainless steel sheets firmly with clamps to smooth, flat copper chill plates. The diameter of welding rods should be nearly the same as the thickness of the sheets except for thicknesses over 1/4", where a 1/4" diameter rod will do. All surfaces should be clean and free from scale before welding. A slightly oxidizing flame is recommended for prevention of bead carburization. A small almost neutral flame is directed in a pre-heating manner toward the unfinished part of the work while the welding is done straight ahead. Do not "puddle."

The straight chromium grades of stainless are usually welded with a rod of a composition near that of the material being welded. This class of alloys, when being welded, has a tendency to grain growth in the welded area causing them to become brittle. At room temperatures, these welds usually possess little ductility and should not be subjected to deformation or shock. Annealing for various periods of time is said to partially overcome the brittleness of these welds.

Soldering

Alloys of the 18-8 type can be readily soldered if the usual precautions are observed. Surfaces should be thoroughly clean and if the metal has a polished finish, the fluxing agent should be comparatively strong and a longer etching time allowed. Roughing the joint surfaces with emery paper or an emery wheel is helpful when the metal is highly polished. Commercial hydrochloric acid in contact with the joints for several minutes will give a good etch. Care should be taken to prevent the acid or flux from coming in contact with the metal away from the joint as this will cause staining. Large soldering irons heated to moderate temperatures are preferred to small irons heated to higher temperatures since these alloys have low heat conductivity. The 50:50 tin-lead solder is usually satisfactory although the 60-40 or 70-30 solders will be found to give extra strength and will stay liquid in the joint more readily thus reducing actual operating cost in spite of the fact that the per pound cost is slightly higher. Direct flame soft soldering is not recommended except on the light gauges since the danger of carbon pick-up is present. It is advisable to make joints mechanically sound before soldering by lock seaming or spot welding. The high tensile strength of stainless steel alloys causes a spring-back or tension at the joint, while the high expansion and contraction coefficient tends to break the solder from the metal during service.

Hard soldering or brazing is not recommended, as the brazing alloy penetrates into the grain boundaries of the metal causing lower corrosion resistance and embrittlement.

Finishes and Finishing

Since stainless steel is obtainable in various sheet finishes, a description of some of them is given below:

- No. 1—Hot rolled, annealed and pickled.
- No. 2B—Full finish (bright cold rolled).
- No. 2D—Full finish (dull cold rolled).
- No. 4—Standard polish on one or both sides.
- No. 6—Standard polish, tampico brushed on one or both sides.
- No. 7—High lustre polish on one or both sides.
- No. 8—Mirror finish on one or both sides.

Although the architect or designer will probably select the finish to produce the special effect desired, certain restrictions should be borne in mind and the advice of your metal representative or distributor secured on any problem which concerns the finish. For example, the finish possible on the stock will depend to a considerable extent on the amount of forming necessary. It is advisable to use polished sheets for extra deep drawing operations where marks from dies are likely to occur in forming or where it is necessary to re-anneal to make a second drawing operation.

Numerous applications of the No. 1 finish may be made where appearance is not the primary factor but where corrosion resistance is important, such as mail chutes, tanks, tubing, etc.

Nos. 2B and 2D finish are the same as No. 1 except that they have a slightly higher finish due to the cold rolling process.

Polished finish should be used only where stock will be employed without further working, where the degree

of working is small, or where the finish can be protected so that excessive refinishing is unnecessary.

No. 4 finish being ground and polished, is satisfactory for interior applications. It possesses a ground surface appearance with medium lustre and is considered the best commercial type of finish for such applications as bank vaults, restaurant and soda fountain equipment, sterilizers, laundry machinery, cold storage, canning and preserving equipment, trim for cabinets and numerous other places where a fairly high lustre and ease of cleaning are desired.

No. 6 finish has a silvery lustre and does not have as high a reflectivity as No. 4. It can often be used to blend in conjunction with finishes of higher lustre or other metals. Higher lustre finishes, such as No. 7, are obtainable and are similar to No. 4 with the exception that the lustre obtained by buffing is much brighter.

No. 8 finish is the highest obtainable in commercial steel practice. All of the grinding lines are removed and a sheet of high reflectivity is obtained. This finish is used for mirrors and trim where highest lustre is required.

Finishing

When polishing and buffing operations must be performed on articles that have been through the fabricating processes, the sequence of operations will depend on the condition of the metal as it comes to the finishing department. Die marks, scratches and rough edges usually have to be removed by dry wheel operations. The handling of the metal before and during fabrication is very important. This holds true for any metal that is to be given a high finish, whether plated or not. This has been discussed very clearly by F. Fulforth* in a previous issue.

The selection of grain size for polishing wheels is of primary importance when polishing stainless steel. When grades coarser than 120 are used dry, the scratches will be very difficult to remove, and it is therefore suggested that 120 grain be established as the largest grain size to be used on this metal. On the other hand, grain sizes smaller than 220, when used on dry wheel operations, are apt to pack particles of steel between the grains with resultant bad scratching from these particles.

Various grades of greaseless polishing compounds used on cloth wheels give very pleasing results for some applications. For buffing operations, peripheral speeds higher than those ordinarily used are necessary for economical results. Buffing wheels of high-count, unbleached muslin sheeting, in the ventilated and folded face type, have been found to give longer life. These wheels are usually operated at 8,000 to 10,000 surface feet per minute using a composition of unfused alumina or a compound of chromium oxide. Overheating of the work and the wheel should be avoided by pressure regulation. Where mirror finishes are desired, the final wheel operation should be on a soft cotton or flannel buff using a dry chromic oxide composition.

The author wishes to acknowledge indebtedness to the distributors and makers of stainless steel alloys who supplied much of the material used herein. Special acknowledgment goes to Mr. S. E. Kelius of The American Rolling Mill Co., for very helpful information and the photographs.

*F. Fulforth. Constructive Preplating Methods. Metal Industry, June, 1939.

The Protection of Silver By the Electrolytic Deposition of Beryllia*

It has been shown in a previous paper that the tarnishing of silver and silver alloys can be greatly diminished by the deposition on their surface of thin invisible films of hydrated beryllia or alumina by an electrolytic method. The conditions necessary for the production of highly tarnish-resistant films from a solution of beryllium sulphate have been investigated. The pH of the solution must be between the pH corresponding to the formation of the basic sulphate $\text{BeSO}_4 \cdot \text{Be}(\text{OH})_2$ and the pH for the complete precipitation of the hydroxide. Observations of the cathode potential during the deposition have shown that it is possible to follow the formation of the film of beryllia. Protective films on silver have also been obtained by cathodic treatment in solutions of beryllium nitrate, beryllium chloride, aluminum chloride, and aluminum sulphate. Two explanations of the formation of these films have been suggested.

Introduction

During the course of an investigation on tarnishing reactions^{1, 2} it was shown (by an extension of Wagner's theory of tarnishing reactions³) that a metal should become resistant to attack by a gas when covered with a film, such as an oxide film, of high electrical resistance. The film formed on heating in air an alloy of copper containing a small percentage of aluminum consists largely of aluminum oxide, and, as such, tends to protect the metal against further oxidation. The protection afforded, however, is much less than that calculated theoretically, although a value of the order of that indicated by theory can be obtained if the oxide layer first formed is absolutely free from the oxides of copper. Such films can be obtained by heating aluminum-copper alloys in atmospheres containing only an extremely small pressure of oxygen. Full details have already been published.¹ Similar films on silver alloys containing aluminum prevent the tarnishing of that metal also.²

An alternative method of obtaining films of alumina and beryllia, by cathodic electrodeposition from baths of beryllium or aluminum salts, has also been described.² This method has the advantage that the films can be applied to a wide range of metals or alloys, and does not depend on the presence of aluminum or beryllium in the basic metal. These films give silver a very high resistance to tarnishing, and preliminary details have already been published.^{2, 4}

Difficulty in repeating the results led to a closer investigation of this somewhat novel method of obtaining tarnish-resistance, and it was found that protection could

By L. E. Price, M. A., Ph. D.

Research Department,
Mond Nickel Co., Ltd.,
Birmingham, England

and G. J. Thomas, B. Sc., Ph. D.

Goldsmiths' Metallurgy Laboratories,
University of Cambridge

only be obtained over a certain rather limited range of pH values, and that, even within this range, the form and adhesion of the deposited film varied considerably. A decrease in the polarizing current during treatment led to a study of the changes in potential of the silver during cathodic treatment, and a somewhat clearer understanding of the processes involved has resulted.

Britton⁵ has investigated the changes in the hydrogen-ion concentration occurring during the addition of sodium hydroxide to solutions of aluminum and beryllium salts. The changes taking place during the addition of ammonium hydroxide have now been found to be similar, and it has been possible to correlate these changes with the range over which protection against tarnishing can be obtained and with the changes occurring in the electrode potential during the deposition of the film.

Experimental Results

A.—In Beryllium Sulphate Solutions.

(1) *General Conditions for Formation of Films.*—The experimental procedure was simple, consisting of treating sheets of fine silver* cathodically at a current density of 50 microamp./cm.² for 15 minutes in solutions containing 3.4 gm./liter of beryllium sulphate ($\text{BeSO}_4 \cdot 4\text{H}_2\text{O}$) and varying amounts of ammonia. A short length of platinum wire served as the anode. In each case the pH of the solution was measured, using a quinhydrone electrode. The cathode potential was measured potentiometrically against a calomel electrode every few seconds throughout the treatment. The specimens were

* Except where otherwise stated, the films of beryllia or alumina were always deposited on hard-rolled fine silver sheet, 0.1 mm. thick, obtained from Messrs. Johnson Matthey and Company, Ltd., and of a purity not less than 99.9 per cent.

*Reprinted from the Journal of the Institute of Metals, 65, (1939).

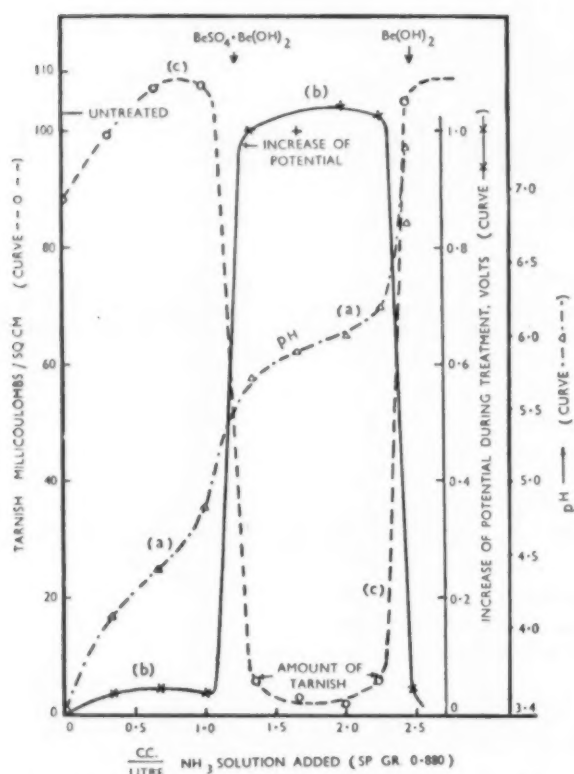


Fig. 1. Amount of tarnishing shown graphically after exposure for 30 minutes to fumes of $(\text{NH}_4)_2\text{S}$.

removed, rinsed several times in distilled water, and dried between blotting paper. The tarnish-resistance so obtained was determined by exposing the material to the fumes from yellow ammonium sulphide diluted to 10 volumes with water, and measuring the tarnish product by the method described elsewhere.^{2, 6} The values obtained for (a) the pH of the solution, (b) the increase in electrode potential during treatment, and (c) the amount of tarnishing* after exposure for 30 minutes to the fumes from ammonium sulphide are shown in Fig. 1. The graph giving the amount of tarnishing after 300 minutes is similar to that for 30 minutes.

The manner in which the "flat" part of curve (a) coincides with the range over which high values on curve (b) and low values on curve (c) are obtained, is somewhat remarkable. The reasons will be discussed later in this paper. Identical results were obtained when the films were deposited on sterling silver.

(2) *Variation of Tarnish-Resistance with Time of Treatment.*—Silver sheet was treated in a bath of beryllium sulphate at pH = 5.83 for varying periods, and the material was tested by exposure over ammonium sulphide solution for 30 or 300 minutes. The values obtained are given in Table I.

(3) *Variation of Wear-Resistance of the Film with Time of Treatment.*—If these tarnish-resistant films are to have any application as protective coverings they must have considerable resistance to abrasion. In order to investigate this, a series of simple tests was carried out. Specimens which had been treated for varying periods in a bath of beryllium sulphate (pH = 5.82) were subjected to the following treatment. An area of about 2 cm.²

* The tarnish was measured by noting the charge required to reduce the product to the metallic state.

TABLE I.

Time of Electrolytic Treatment, Minutes	Potential Increase in m.v.	Equivalents/cm. ² × 10 ⁻⁸ Ag S Formed after Tarnishing	
		30 Minutes	300 Minutes
0	(untreated)	151	678
1/2	20	86	344
1	77	75	272
2	204	43	264
3	957	3.2	12
4	972	3.8	4.4
7	996	3.3	4.2
15	1015	2.2	5.2
30	1054	4.5	3.2

was marked off and rubbed by hand as hard as possible with Selvyt cloth for 12 periods of 10 seconds each. These specimens were then exposed to fumes from ammonium sulphide for 1 hr., together with similarly treated silver that had not been rubbed, and with untreated silver. Subsequently, the amount of tarnish on the specimens was measured and the results are given in Table II. Similar results are obtained when films are deposited on sterling silver.

TABLE II.

Tarnish, Equivalents/cm. ² × 10 ⁻⁸			
Time of Electrolytic Treatment, Minutes	Rubbed Material	Unrubbed Material	
Untreated	...	250	232
5	147	8.2	
20	18.5	3.1	
80	9.2	6.2	
pH of beryllium sulphate solution = 5.82.			

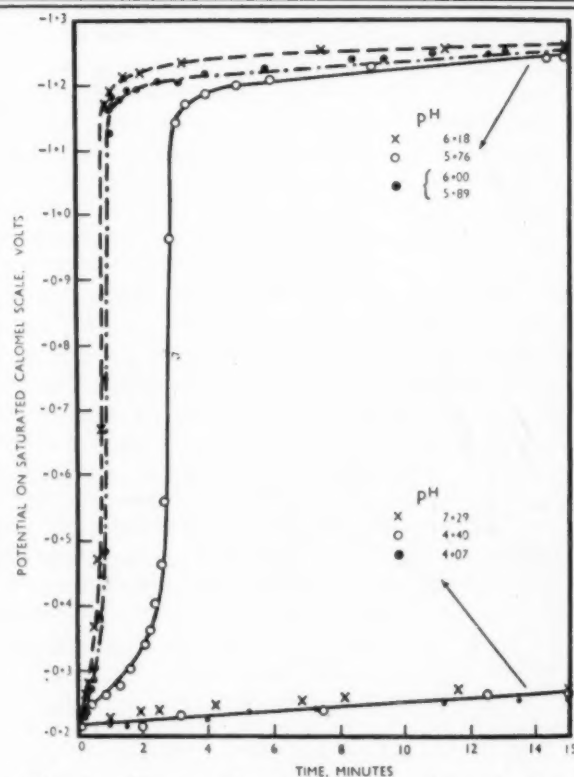


Fig. 2. Change of potential with time of silver treated cathodically in baths of varying pH solutions.

(4) *Increase of Potential During Treatment.*—Fig. 2 shows the change of potential, with time, of silver treated cathodically in baths of varying pH values. Other experiments have shown that, even within the range of pH over which protective films can be obtained, the increase of potential does not always occur equally quickly, and that it is slowest at pH values at the acid end of the range. At the alkaline end of the range the increase occurs within about 1 minute when using a current density of 90 microamps./cm.².

Owing to this increase in potential, the throwing power of the solution is high, good protection being obtained even on parts furthest removed from the anode; on these portions, however, the resistance of the film to rubbing tends to be lower than elsewhere.

(5) *Effect of Cleaning Treatment on Appearance of the Protective Film.*—Normally, the fine silver sheet was cleaned by degreasing with acetone vapor for 2-3 hrs. before treatment in the beryllium sulphate solution. It has been found recently that cathodic cleaning of the silver in sodium carbonate solution at 5 amp./dm.² for 10 minutes, and then thoroughly washing, gives better results, particularly in reducing the tendency of the deposited films to have a cloudy appearance.

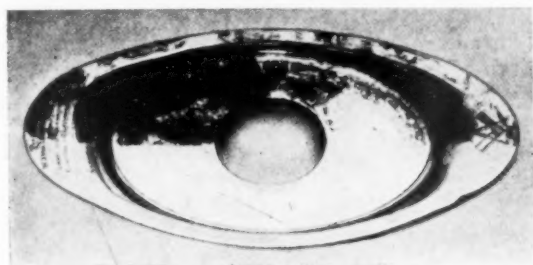


Fig. 3. Inkpot stand after four months' exposure, showing effect of protecting one half with film of beryllia.

(6) *Wettability of Film.*—The most tarnish-resistant films were usually found, after exposure over the ammonium sulphide solution, not to be wetted by water. This is rather surprising in films formed electrolytically.

B.—In Beryllium Nitrate Solutions.

The experiments described under A (1) were repeated, using beryllium nitrate solutions, and almost identical results were obtained. It was found that the "flat" portion of the pH curve coincided with the range of high values on the potential-increase curve and with the range of low values on the amount-of-tarnish curve. Probably owing to the depolarizing action of nitrate ions, the cathode potential at film-covered surfaces never reached values more negative than -0.6 v. (saturated calomel scale), and the potential increases were therefore smaller. The degree of protection conferred on silver approached the same high values as those obtained by treatment in beryllium sulphate solution.

C.—In Other Solutions.

Positive results have also been obtained by using solutions of beryllium chloride, aluminum chloride, and aluminum sulphate, but no detailed results regarding the

deposition of films from these solutions are yet available. An attempt was made to deposit films of silica on silver by this process. Using a solution of sodium silicate with varying amounts of sulphuric acid added, no evidence was obtained of a silica film on the cathode, and the potential remained constant.

Application of the Method to Service Specimens

Fig. 3 shows the tarnishing of a sterling silver inkpot stand, half of which was treated electrolytically, using a beryllium sulphate solution with a pH of 5.77. The article was exposed in a fume cupboard in which a small amount of ammonium sulphide solution had been placed. Since treatment, the article has been exposed, freely handled, and exhibited for 4 months, but there is no trace of tarnishing on the treated portion even as a result of scratching. Fig. 4 shows two sheets of fine silver, parts of which were treated, and the entire specimens were exposed in a sitting-room for 75 days.

Discussion

Comparison of Fig. 1 with the results of the work of Britton shows that protective films can only be deposited from solutions whose composition lies between $\text{BeSO}_4 \cdot \text{Be}(\text{OH})_2$ and $\text{Be}(\text{OH})_2$. From solutions more acid or more alkaline than these no film deposition is possible. Solutions whose acidity lies between the above limits are colloidal and the particles are almost certainly positively charged, while the alkaline solutions probably lie beyond the iso-electric point and the particles are negatively charged.

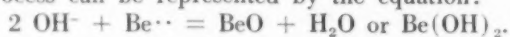
Two mechanisms may be suggested for the process of deposition: (1) Free alkali results from cathodic treatment and, in solutions already saturated with BeO or $\text{Be}(\text{OH})_2$, precipitates a film in close contact with the surface. (Solutions more acidic than $\text{BeSO}_4 \cdot \text{Be}(\text{OH})_2$ contain no precipitate and show no film formation.) The precipitate, being positively charged, is attracted to the surface and adheres firmly. (2) Solutions in the given range of acidity are colloidal, and the particles, being positively charged are attracted to, and deposited upon, the surface by cathodic treatment.



Fig. 4. Partly treated specimens of silver after exposure in a sitting-room for 75 days.

Whichever explanation is correct, it seems probable that the film so deposited, if gelatinous, will tend to be dried by electrical endosmose during cathodic treatment. The amount of current which must be passed at a current density of 10^{-4} amp./cm.², before the potential increases to the high value, is about 5×10^{-3} coulomb/cm.²—sufficient to cover the surface to a depth of about 30 Å.

if the efficiency of the process be 100 per cent, and if the process can be represented by the equation:



This value of the thickness is compatible with either theory of deposition.

Adhesion of the Films.—Although the resistance of the films to removal by rubbing is usually quite high, some lack of reproducibility in this respect has been noticed, and further study is being made to elucidate this point. The maximum resistance to wear actually noted is rather surprising, and special factors must be involved. It has been found possible to deposit these films upon clean silver, copper, iron, and even upon tarnished silver, but, in the few tests that have been made, the deposit upon nickel was loose and easily removed. Possibly the fact that silver, copper, and iron oxides, and silver and copper sulphides are readily reduced cathodically, ensures the production of a clean (oxide- and sulphur-free) surface to which the film will adhere firmly. The possible relationship between adhesion of the film and the method of cleaning of the silver before treatment is now being investigated.

Isolation of the Film.—When a film-covered sheet of silver foil is floated on a bath of mercury, the silver is dissolved and the film floats freely upon the surface of the mercury; it has been possible to remove the film in this way and to transfer it to the surface of celluloid.

Visibility of the Film.—Under the optimum conditions the film is invisible, being too thin to give interference colors. If, however, the current density is too high or the treatment too prolonged, the film thickens and faint interference colors are seen; for many purposes these tints are undesirable, though very beautiful ("mother-of-pearl") effects can be obtained if desired. If the film is very thick, it becomes visible. Deposits formed when using solutions whose pH is too near the alkaline end of the range over which deposition occurs, tend to be visible and loose; in this case, due to cathodic formation of alkali, the solution in the immediate neighborhood of the cathode is too alkaline for precipitation and the precipitate is formed at a distance from the surface. Deposits formed at very high current densities are also loose and visible; in this case the alkali is formed more quickly than beryllium ions can diffuse up to the electrode, and the deposit is again formed at a distance from the surface.

Conclusion

By cathodic treatment of silver in solutions of beryllium salts (containing sufficient ammonia to bring the composition between the limits of $\text{BeSO}_4 \cdot \text{Be}(\text{OH})_2$ and $\text{Be}(\text{OH})_2$) a thin film of beryllia which renders the metal highly resistant to tarnishing can be deposited on the surface.

ACKNOWLEDGMENTS.

The authors gratefully acknowledge the continued financial support of the Worshipful Company of Goldsmiths. They thank Professor R. S. Hutton, M.A., D.Sc., and Dr. U. R. Evans, M.A., for their keen interest and valuable criticism, and also Mr. A. W. Hothersall, M.Sc.Tech., for helpful discussion on cleaning metal surfaces. They are again indebted to Mr. A. G. Shadbolt for much careful assistance.

References

- ¹L. E. Price and G. J. Thomas, *J. Inst. Metals*, 1938, 63, 21.
- ²L. E. Price and G. J. Thomas, *J. Inst. Metals*, 1938, 63, 29.
- ³C. Wagner et al., *Z. physikal. Chem.*, 1933, (B), 21, 25; 1936, (B), 32, 447; 1938, (B), 40, 455.
- ⁴British Patent Application, February 9, 1938. No. 4087/38.
- ⁵H. T. S. Britton, *J. Chem. Soc.*, 1925, 2121; 1927, 422.
- ⁶L. E. Price and G. J. Thomas, Unpublished work.

Abstracts of Papers Presented at the New York Meeting of the Electrochemical Society (concluded from the October issue).

Rectifier Equipments in the Electrochemical Field. By F. L. Kaestle.

The major operating requirements and conditions imposed upon power conversion equipment in the electrochemical field are discussed. The means by which mercury arc rectifiers have met these requirements, and have provided additional advantages not easily attainable with other equipment, are emphasized. Both the multianode and ignitron types of rectifiers are discussed from the users' operating viewpoint. It is expected that the use of the ignitron will increase. It not only retains the known advantages of the multianode type, but provides even better efficiency and additional desirable features. By its extended use, these additional advantages can be further realized. For the sake of clarity, a brief review of construction features is presented.

The Cadmium-Nickel Storage Battery. By Anna P. Haul.

The cadmium-nickel battery is widely used in Europe but not in America. It is particularly applicable to severe service conditions since the active material does not shed readily and wide temperature fluctuations have but little effect. The active material of the positive plates is nickel hydroxide plus pure crystalline graphite. In place of graphite, metallic nickel flakes may be used. The active material of the negative plates is cadmium oxide or hydroxide. The effect of the presence of iron in the cadmium paste is discussed at length. Similarly the addition of lithium hydroxide to the KOH electrolyte is treated at length. On the basis of the author's experiments, the lithium appears superfluous in positive electrodes containing graphite except that it counteracts the deleterious effects of traces of iron. The adsorption of CO_2 by the KOH electrolyte reduces the capacity of the battery, due to cadmium carbonate formation on the surface of the CdO grains. The new starting battery has very thin plates and very close spacing. It is replacing the lead storage battery in trucks and buses.

CORRECTION

The credit caption for Figure III, page 418 of the September 1939 issue was inadvertently omitted. The photograph and descriptive matter, describing chromium plating of briquet dies were furnished through the kindness of Chromium, Incorporated of 626 So. Fifth St., Milwaukee, Wisconsin. The editor wishes to express his apologies for this unfortunate omission.

General view of plant for applying
Amaloy coatings.



High Lead-Low Tin Alloys As Coating Materials

By Joseph B. Kushner, Ch. E.

Personalized Plating Service Co.,
New York

All of our tin is imported and in times of war it becomes a strategic metal. This article discusses briefly the use of lead with small amounts of tin as a coating material. Special applications such as its use as a drawing lubricant for wire drawing are also mentioned.—Ed.

Introduction

There are many metals in everyday use which we never give a thought until, suddenly, war looms on the horizon. Then, all at once, prices skyrocket, users hoard it, worry about where they will get more and we hear of it as a "strategic war material."

Such a metal is tin. Always with us in the form of solder, bronze, babbitt metal and the ubiquitous tinned can, it seems difficult to realize that this metal can become scarcer than hen's teeth, more precious than gold, when the dogs of Mars are growling.

Most of the tin we get comes either from the Straits Settlements or its neighbor the Dutch East Indies. Yearly production of the metal hovers around 200,000 tons and the price of it during normal times never goes much above fifty cents a pound but comes a crisis, freight shipping on the seven seas is drastically curtailed or halted by naval blockades, and the price goes up to whatever you can get it for. That is why nations always make sure to have a nice

stock of tin on hand; babbitt metal, solder and bronze are all necessary to keep a good war going, and "canned goods," to paraphrase Napoleon, "is what the army crawls upon."



Joseph B. Kushner

Uses of Amaloy

For these particular uses, tin seems almost irreplaceable, but there are

some "strategic" uses of tin not mentioned above which can be better had from other metals. These particular uses are: (1) As a coating for ferrous and cuprous metals to prevent their oxidation and rusting. (2) as a coating for insulated copper wire, to prevent the tarnishing and mutual attack between copper and the sulphur-bearing compounds in the rubber. A particular alloy which can be substituted for tin in some instances, and which has many virtues of its own, goes under the trade name of "Amaloy".*

Amaloy is a series of lead-tin alloys in which the percentage of tin ranges from 1/2% to a maximum of 10%. In its formulation, the alloy passes through a patented process of treatment which imparts to it good wetting power and adhesion. This is the secret of its usefulness. As is well known, hot dip lead coatings cannot successfully be applied to ferrous metals unless some terne-plate, an alloy of 80% lead, 20% tin, is put on first, because pure lead does not alloy with or wet the surface of iron or steel. Amaloy, although a very high lead alloy, seems to do the trick at once.

It makes an excellent substitute for tin in covering copper wire that is to be rubber insulated. It is the only substitute for tin in this respect, that has passed the U. S. Army Signal Corps' requirements and is approved by the Underwriters' Laboratories.

A second important place where it can be substituted for pure tin is as a dip soldering and coating material on air conditioning coils and

*Copyrighted name owned by American Machine & Foundry Company, Brooklyn, N. Y.

refrigerator condensers. It possesses all the chemically resistant characteristics of pure lead yet it is tougher and harder than lead because of its tin content, and it is materially cheaper than "half and half" or other high tin solders.

Amaloy has other properties which make it useful in fields where tin dare not tread. Thus it is an excellent coating for battery hardware. Battery parts such as illustrated in Figure 4 are subject to powerful corrosive attack by sulphuric acid; here tin would be out of the question but lead is not. Another interesting use of Amaloy is as a coating for flue gas economizers. Large industrial plants burn cheaper grades of coal containing appreciable amounts of sulphur. In flue gas economizers or heat exchangers, the heat of the gas is utilized to pre-heat air entering the combustion range. Through oxidation, sulphuric acid is formed from the sulphur dioxide in the flue gas. This would rapidly corrode the heat transfer apparatus if it were not coated with lead.

Perhaps the most interesting use of Amaloy is as a lubricant for wire drawing or other metal forming. Wire drawing is particularly difficult on materials such as stainless steel. To reduce stainless steel from 3/16" to a hair's breadth requires 5 to 6 intermediate annealings of the steel wire. If the stainless steel is first coated with Amaloy, only two annealings are necessary. The tin content of this particular alloy is 2 1/2%.

It may also be used as a coating on pipe fittings and bolts, without the necessity for recutting the threads as its high wetting power permits it to perfectly align itself with the contour of the work.

Method of Applying Alloy

The method for applying Amaloy is the same as in hot dip galvanizing. The temperature range of application is between 650° and 750° F. The operations consist of (1) degreasing the work; (2) pickling; (3) fluxing with zinc chloride-ammonium chloride flux; (4) dipping. After dipping, the work is quenched in water.

Acknowledgment — The author wishes to gratefully acknowledge the assistance given him by Mr. W. S. Gleeson of the Amaloy Division of American Machine and Foundry Co., Brooklyn, N. Y.



Fig. 2. Dipping of articles in Amaloy (center tank). Tank on right is for quenching.

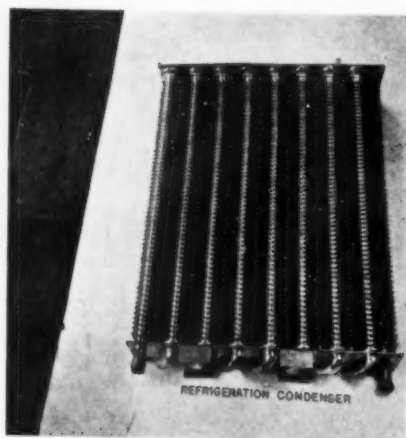


Fig. 3. Refrigerator condensers coated with Amaloy.



Fig. 4. Amaloy coatings give good protection to battery hardware.

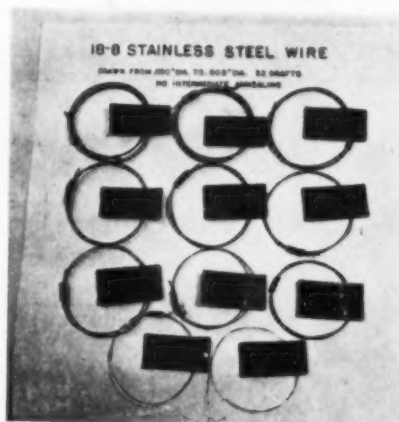


Fig. 5. Amaloy coatings reduce number of anneals between draws on stainless steel wire.



Fig. 6. Miscellaneous parts coated with Amaloy.

Anodic Coating of Aluminum*

By Dr. Junius D. Edwards

Research Laboratories,
Aluminum Co. of America,
New Kensington, Penna.

A comprehensive paper describing the properties of anodic coatings on aluminum alloys. The author considers the color and appearance of anodic films as determined by the composition of the alloys treated as well as their physical condition. The adsorptive, abrasion resistive, reflective, radiative, electrical, mechanical, thermal and weathering characteristics of anodic coatings are discussed.—Ed.

Introduction

The anodic treatment of aluminum is both an old and a new art. The functioning of certain types of anodic films in electrolytic condensers and rectifiers has long been the subject of extensive scientific investigation and commercial application. The extensive use of anodic coatings for the decoration and protection of aluminum surfaces is a later development. Today, anodic coating is used annually as a finishing process for many million pounds of fabricated aluminum articles and structural parts.

If aluminum is made the anode in certain electrolytes, of which solutions of boric acid and borax are typical, an oxide film is rapidly formed. After the initial surge of current the resistance of the film rises to a high value and the current falls correspondingly. When fully formed, the film is thin but quite *impermeable* and is an effective bar to the passage of current. This is the type of film used in the electrolytic condenser.

In other types of electrolytes, such as solutions of sulfuric acid, the film remains *pervious* to the electrolyte and current continues to pass more or less indefinitely with continued growth in oxide formation. It is with relatively thick oxide films of this latter type that this article is concerned. These oxide films have a variety of properties, such as resistance to abrasion, to corrosion, ability to adsorb substances, etc., which adapt them to many applications.

In a historical way, anodic coatings formed in chromic acid electrolytes were first used commercially. Bengough and Stuart¹ in England developed the use of a 3 per cent solution of chromic acid as the electrolyte for the oxide coating of duralumin, particularly in aircraft structures. Almost simultaneously, Flick¹³ developed an ad-

sorptive oxide coating and discovered that adsorptive oxide coatings could be made electrolytically and colored with dyes. Other forward steps were taken by Gower¹⁴ and Bengston² in discovering the advantages of oxide coatings made in sulfuric acid electrolytes of certain concentrations; the color, hardness and adsorption characteristics of these coatings offered substantial improvement over prior coatings. They form the basis of the well known Aluminite process,—used both in this country and abroad; in Germany, the Eloxal process also employs these methods¹². Some use has also been made of oxalic acid solutions for the anodic coating of aluminum, particularly

in Japan and Germany. Direct current is usually employed in the electrolytic oxidation of aluminum but there is a limited use of alternating current for special purposes, as well as the use of alternating current superimposed on direct current.

The film formed on aluminum in the anodic coating process is essentially aluminum oxide. This is true with any of the commercially used electrolytes. The film may contain substances adsorbed from the electrolyte, such as sulfate, and its properties may be modified thereby, but basically, the composition is Al_2O_3 . The use of the X-ray seldom discloses any pattern characteristic of the crystalline state, although there are reports of some investigators that the oxide is present in the gamma form ($\gamma-Al_2O_3$).

Keller, working in Aluminum Research Laboratories, has found that anodic coatings made with different electrolytes have different optical properties, as can be shown by examination with polarized light¹⁶. The refractive index of oxide films made by electrolytic oxidation of sheet aluminum of 99.95 per cent purity, in dilute sulfuric acid electrolyte has been



Dr. Junius D. Edwards

*Reprinted from The Monthly Review A.E.S. 26, pp. 513-532, (1939).

determined by immersion of the isolated film in liquids of known refractivity. Observed in white light, the refractive index of the unsealed oxide was 1.59. After sealing by treatment in hot water the refractive index was increased to 1.62. The refractive index changes appreciably with differences in the method of production and sealing.

Natural Color of the Film

Aluminum oxide itself is relatively colorless, but the oxide coating on aluminum may be tinted, either because of the presence of minor impurities comprising iron, silicon, etc., derived from constituents in the metal, or because of adsorbed or occluded substances coming from the electrolyte. Coatings on commercial aluminum sheet (2S) made in chromic acid electrolyte, for example, have a gray or greenish tint. Coatings made in some of the sulfuric acid electrolytes are the brightest of all and, when produced on clean aluminum of high purity, are transparent and glass-like in appearance. This is only one of the reasons why the use of sulfuric acid electrolyte has become almost universal.

The natural color of the oxide film may be profoundly modified by alloying elements in the metal or even by minor impurities. During the anodic coating process some alloying elements or constituents are dissolved and

consequently have little effect upon the color of the film.^{17, 18} Other elements or constituents, however, may be retained or occluded within the film and modify its appearance. Silicon present as an impurity in commercial aluminum may lend an appreciably brownish or gray tint to the oxide film unless the silicon is substantially all in solid solution or extremely well dispersed. Where relatively large amounts of silicon are present, as in certain alloys, the oxide coating will have a brown to black color because of the presence of silicon in the oxide film. Chromium constituent frequently lends a yellow or golden tint to the coating. While magnesium forms a white, colorless oxide, some of the aluminum-magnesium alloys containing substantial amounts of undissolved magnesium constituent have a dark appearance when anodically coated⁴. This is ascribed to the presence of precipitated aluminum-magnesium constituent, and the color is decidedly lightened by heat-treatment, adapted to put this constituent into solid solution, before oxidation. In general, the heat-treatment of alloys before oxidation results in a lighter colored coating. Alloys containing substantial amounts of the constituent $MgZn_2$ may be given a gold or brassy colored coating by anodic oxidation.

Appearance

Instead of a uniform, structureless appearance, an oxide-coated surface may sometimes exhibit streaks, often approaching some regular pattern in their uniformity. These streaks are generally undesired, but insuring their complete absence is very difficult because they result from structural characteristics of the original ingot which persist in the worked metal. Progress has been made in eliminating them in certain types of products, but the metal used for many purposes will show more or less of this effect after oxide coating.

The appearance in cross-section of an oxide coating on commercial aluminum sheets is shown in Fig. 1; the thin black line is the oxide coating. In Fig. 2 is shown an oxide coating on an aluminum alloy containing 5 per cent of silicon, and particles of silicon are clearly visible in the coating. Fig. 3 shows a cross-section of an aluminum alloy containing 10 per cent copper, after long-time electrolytic oxidation; the oxidation has penetrated along grain boundaries and through eutectic areas. The apparently detached areas of oxide are connected with the surface through channels lying in other planes than the one photographed.

It is not usually practical to match exactly in appearance, the different oxide-coated parts of a structure when they are made from different alloys and from both wrought and cast members. Much can be done, however, by proper selection of the alloys employed. Welded joints present a problem, since the heat of welding may produce a heat-treatment effect in surrounding areas and cause a change of color in subsequently applied oxide coats. Furthermore, if the welding rod is of different composition, it provides another source of color variation.

The appearance of an oxide-coated surface can be given many useful and artistic variations by suitable treatment before anodically coating. This treatment may be a part of, or constitute the cleaning necessary to prepare the article for the electrolytic oxidation. The oxide coating

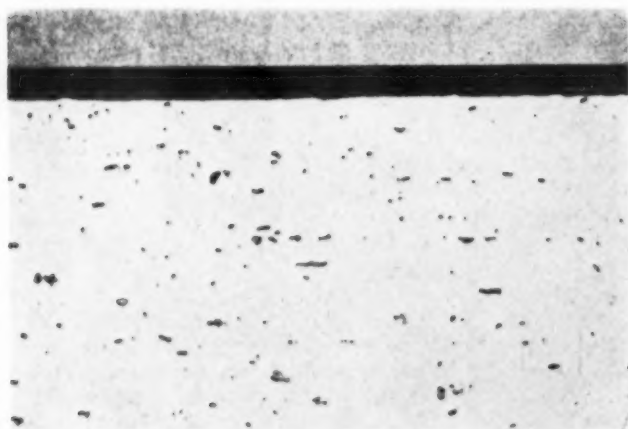


Fig. 1. Cross-section of an oxide coating (black line) on commercial aluminum sheet.

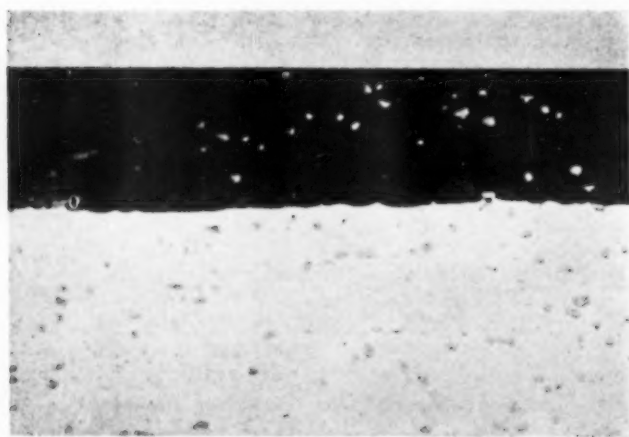


Fig. 2. Oxide coating on a 5% silicon-aluminum alloy. White specks are silicon.

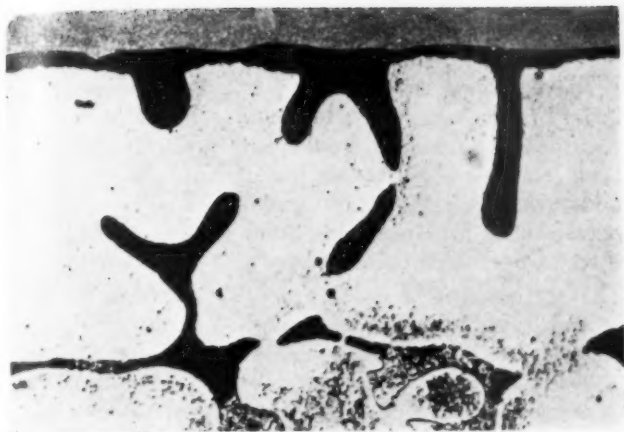


Fig. 3. Cross-section of aluminum alloy with 10% copper after long-time oxidation.

on wrought products is quite uniform in thickness, as a rule, and hence follows surface irregularities with fidelity. The surface may be buffed for smoothness or etched to give it light-diffusing characteristics. Sand blasting gives good diffusion and is frequently employed as a surface finish on castings which are to be anodically coated. If the surface is not cleaned after blasting, the coating will have a darker hue than usual. Sand blasted backgrounds with adjacent areas high-lighted by buffing give interesting contrasts in color and texture. Satin finishing before anodic coating may be employed to reduce any appearance of streaking.

Thickness of the Film

The thickness of the oxide coating which can be formed on aluminum is limited principally by the amount of current employed. With a current density of 12 amperes per square foot, the oxide coating formed in 15 per cent sulfuric acid electrolyte at 70°F is about 0.4 mil thick after a half-hour's coating period, and 0.7 to 0.8 mil thick after an hour's oxidation. The thickness at intermediate periods is roughly proportional to the amount of current passed.

The oxide last formed is always between the metal and the previously formed oxide. As a result, the outer surface of the film is in contact with the electrolyte from the start, and if the electrolyte has any appreciable solvent action thereon, as sulfuric acid electrolyte may have under some conditions, some oxide will be dissolved therefrom. This will, of course, reduce the total thickness of the oxide coating and may modify its properties, such as resistance to abrasion and porosity. Under some conditions, there may be a net decrease in the thickness of a piece after oxide coating. For these reasons, the coating thickness is not always proportional to the total current, particularly when extended coating times are employed or the electrolyte is heated substantially. Methods of measuring the thickness of oxide films are described in a report of the American Society for Testing Materials¹⁰.

The course of anodic oxidation of a piece of aluminum foil (0.00114" thick) is illustrated in Fig. 4 and by the measurements recorded in Table 1. In the figure, a cross-section of the original foil is shown at the left and a cross-section of the completely oxidized foil at the right, with intermediate stages in between. In the

photomicrograph, the oxide coating appears black and the unoxidized aluminum is bright. It is obvious that the oxide occupies a greater volume than the aluminum metal from which it was formed. The foil, after 30 minutes' coating, had a total thickness of oxide on both faces of 0.90 mil and the foil had increased in thickness by 0.3 mil, or by an amount about equal to one-third the thickness of the oxide coating.

TABLE 1.
Thickness Measurements on Anodically Treated Aluminum Foil

According to measurements by C. J. Slunder and F. Keller Aluminum Research Laboratories.

Time of anodic oxidation	Total thickness of foil-mils	Thickness of oxide coat on one side of foil-mils	Increase in thickness of foil by oxide coat on both sides-mils
0	1.14	0	
10	1.19	0.14	0.05
20	1.29	.26	.15
30	1.42	.45	.28
45	1.50	.59	.36
60	1.62	.80	.48

It is possible to calculate the current efficiency of the oxidation process at the anode upon the assumption that the increase in weight may be ascribed to the formation of Al_2O_3 . This is, of course, not an exact assumption, as there will be a certain amount of adsorbed sulfate, etc., in the coating. On the original assumption, however, the formation in a sulfuric acid electrolyte of a 0.2 mil coating on aluminum of 99.8 per cent purity showed an average apparent current efficiency for six specimens of 75 per cent, and for 2 specimens of 99.2

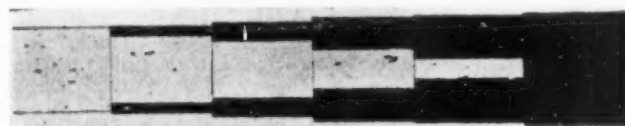


Fig. 4. Progressive oxidation of aluminum foil.

per cent aluminum, the apparent current efficiency was 69 per cent. Finally the oxide coating was removed without attacking the aluminum, and from the original weight of the aluminum and the weight of metallic aluminum left after oxidation, it was found that the aluminum lost corresponded to an apparent current efficiency of 101 per cent. The apparent current efficiency would be increased above 100 per cent if some chemical solution of the aluminum occurred. The figures indicate, however, that the aluminum oxidized or dissolved is about equal to the electrochemical equivalent of the current employed.

Adsorption Characteristics

An important milestone in the history of oxide coatings was Flick's discovery that adsorptive electrolytic oxide coatings could be colored with lake-forming dyes¹³. This ability to be colored extended the field of application of these coatings. While it is true that all dyes are susceptible to eventual fading in sunlight, their resist-

ance to fading differs widely. As a result of extended investigation and selection, satisfactory dyes are available now for most of the wanted colors. Their use under controlled conditions results in colored oxide coatings which resist fading for long periods indoors; even outdoors they may have a limited use for certain applications. The light-fastness of the dyed oxide coating can be increased by suitable sealing treatments. Certain dyes, notably the basic dyes, are not adsorbed by oxide coatings. Tosterud discovered, however, that by first adsorbing a suitable mordant on the oxide, the basic dye could then be adsorbed on the mordanted surface.

The discovery that adsorptive oxide coatings could be colored with pigments by precipitation within the pores has effected more durable means of coloration²⁴. The range of colors is, however, much more limited than is the case with dyes. If, for example, an oxide coating is first treated with a solution of potassium dichromate so as to adsorb chromate strongly within the pores, and the coating is then treated with a solution of lead acetate, insoluble lead chromate is precipitated within the pores of the coating. This both seals the coating and gives it a bright, chrome-yellow color. A jet black is provided by the precipitation of cobalt sulfide, and blue by the precipitation of Prussian blue within the pores of the coating.

Mason discovered that adsorptive oxide coatings could be impregnated with photo-sensitive salts and photographs reproduced thereon by exposure to light through a negative, followed by the usual developing and fixing processes²⁵.

That the oxide is truly adsorptive may be demonstrated by simple experiment. A certain coating made in sulfuric acid electrolyte was found to have a thickness of 0.57 mil and the volume of oxide coat per square meter of surface was 14 cc. This coating was then impregnated by treatment in a boiling 1 per cent solution of potassium dichromate. Upon analysis, the coating was found to contain 0.48 gram chromium per square meter, corresponding to about 1.4 grams potassium dichromate per square meter. This 1.4 grams of potassium dichromate was originally contained in 140 cc. of solution, and since the coating itself had a volume of only 14 cc. (the pore space was something less), dichromate must have been adsorbed from the solution and concentrated on the pore surfaces as fresh solution continued to diffuse into the pores.

Impregnation of oxide coatings with chromates has provided an important means of increasing the resistance to corrosion afforded by oxide coatings⁵. Treatment with chromate helps to complete the oxide coating on the metal at the base of the pores, and the adsorbed chromate provides a ready supply of corrosion inhibitor during any later attack of the surface by a corroding medium. Adsorbed silicate is another corrosion inhibitor which may be employed in this way.⁶

Sealing

The type of oxide coating under consideration is essentially porous as it comes from the electrolytic bath. This must be so, for the electrolyte penetrates the coating and current continues to pass as long as sufficient volt-

age is applied. It is this porosity of the oxide which makes it so adsorptive. However, it lowers the resistance to corrosion and permits undesirable staining and coloring. Anodically coated cafeteria trays, for example, are stained by coffee unless they are given a preliminary sealing treatment. Ice-cube trays must also be sealed against staining. The term "sealing" has been applied to treatments which make the oxide coating impermeable, non-adsorptive, or non-staining.

The sealing process most generally employed is treatment with hot or boiling water³. Highly adsorptive coatings treated in this way become proof against staining. X-ray studies made upon the coating before and after treatment with hot water show that amorphous oxide (Al_2O_3) has been converted into aluminum monohydrate ($\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O}$). Presumably this reaction takes place at the surfaces lining the pores. It is also reasonable to assume that the monohydrate is formed with an increase in volume. The resultant swelling action therefore helps to close the pores and decrease the surface available for adsorption. The color and appearance of the oxide coating are not particularly changed by this water-sealing treatment.

The pores in the coating may also be closed by treatment in hot solutions containing nickel or cobalt acetate²³. Apparently colloidal hydroxides of these metals formed by hydrolysis are occluded or adsorbed in the pores of the coating and help to close them.

Obviously, a variety of materials may be used to seal coatings in order to give them specific properties. Oils, such as linseed oil and tung oil, and waxes, such as lanolin and paraffin, have been used for this purpose. The impregnation may be effected hot or cold. A common practice is to immerse the oxide-coated article in the hot oil or molten wax until any gas in the pores is driven out and replaced with liquid. The wax or other impregnating substance may also be dissolved in a volatile solvent and applied to the surface by dipping, brushing or spraying. In addition to sealing, some of these materials may also function as surface lubricants.

In cases where it is desirable to render any portion of an oxide-coated surface non-adsorptive, it can be sealed in various ways or coated with stop-off materials. Using stop-offs, it is possible to seal selected areas on an oxide-coated article and then completely immerse the article in a coloring solution so that only the untreated parts become colored thereby. By the use of stop-offs, it is possible to reproduce patterns or letters in a number of colors.

Resistance to Abrasion

Crystalline alumina, such as the mineral corundum or emery, is an extremely hard substance and it is not surprising, therefore, that compact electrolytic oxide coatings on aluminum should be resistant to abrasion. The fact should be borne in mind, however, that even though the coating is very hard, it is also very thin, and is supported by a metal base which is inherently softer and less resistant to deformation. Because of the softer supporting material, it is not difficult to scratch through oxide coatings with a sharp-edged instrument, such as a knife. However, for the rubbing type of wear, these oxide coatings give excellent service. They do not

TABLE 2.
Resistance of Oxide Coatings to Abrasion.

Description of Sample	Thickness of oxide coating-mils	Grams of Alundum in air-blast required to wear thru coat	Ratio of abrasion resistance to thickness mils x 10 ²	Revolutions of Crystolon wheel required to wear through the coat	Ratio of abrasion resistance to thickness mils x 10 ²
Hard rolled aluminum, (2S)	.15	30*	2.0	100†	6.7
Brinell number, 44	.30	72	2.4	145	4.8
	.44	110	2.5	185	4.2
	.60	148	2.5	250	4.2
Heat-treated aluminum alloy, 53ST**	.17	35	2.1	78	4.6
Brinell number, 80	.32	79	2.5	225	7.0
	.46	120	2.6	330	7.2
	.60	161	2.7	450	7.5

* Average of 8 observations.

† Average of 2 observations.

** Nominal composition—magnesium 1.3%, chromium 0.25%, silicon 0.7%, balance aluminum.

mark porcelain or enamel surfaces and have the additional advantage that they eliminate smudging such as is sometimes experienced when a white fabric is rubbed against a bare aluminum surface. This is an important characteristic on such an article as a cafeteria tray.

Various methods have been suggested for measuring abrasion resistance and several of these have been found useful in connection with oxide coatings. The abrasive air-blast method appears to give the most reproducible results, while the rotating abrasive wheel appears to show more of the effect of the supporting metal.

Results using the abrasive air-blast method, shown in Table 2, indicate that the resistance to abrasion measured in this way is approximately proportional to the thickness of the oxide coating¹⁰. However, when the abrasion resistance is measured with a rotating abrasive wheel, coatings applied to the harder base metal appear to have a greater resistance to this type of abrasion. Of course, resistance to abrasion may vary with the structure of the coating itself, and this is a factor which must be taken into consideration. The coating tends to become softer as its porosity increases. Long-continued oxidation usually results in some reduction of the abrasion resistance of the oxide at and near the surface of the coating. The most abrasion-resistant coatings are produced on 2S and 3S and some of the magnesium-containing alloys, such as 4S, 51S, 52S and 53S.

Mechanical Properties

The oxide coating will crack on bending but the oxide is adherent and does not flake off. The cracks may not be objectionable under some circumstances and their effect upon resistance to corrosion may be minimized by suitable sealing procedures. Very porous oxide coats may appear to be flexible simply because the cracks which form on severe bending do not show readily. Whenever possible, any necessary mechanical working of a piece should be carried out before oxidation.

Oxide coatings 0.0004 inch thick, made in sulfuric acid electrolyte on .064" 17S-T sheet, had no appreciable effect upon such properties as tensile strength, yield strength and elongation, but flexural fatigue tests on sheet

indicate that an oxide coating results in a slight decrease in life at high stresses and an increase in life at lower stresses. The endurance limit of 17S-T sheet is increased about 1500 to 2000 pounds per square inch by an oxide coating.

Reflection and Radiation Characteristics

A pure aluminum surface has a reflectivity of about 90 per cent for visible radiation, and the reflectivity rises in the infra-red region of the spectrum to values as high as 97 per cent. Aluminum is also a good reflector of ultraviolet radiation. These aluminum surfaces, of course, have the natural oxide film which always forms on exposure of the metal to air, and which is on the order of 1 or 2 x 10⁻⁶ centimeters in thickness. If the aluminum is covered with a thicker oxide coating produced by chemical or electrochemical means, its reflection characteristics will be modified. Within the range of commercial thicknesses, the reflectivity for light decreases somewhat as the thickness of the oxide coat increases. This loss of reflectivity after anodic coating also increases as the content of the metal in such elements as iron and silicon, for example, increases.

In the infra-red region, the optical characteristics of aluminum may also be modified in an important way by oxide coating²². In Figure 5 is shown a graph giving the relationship between the emissivity at 100°F and the thickness of oxide coat upon aluminum. The emissivity or radiating power is expressed as a percentage of the radiating power of a black body at the same temperature—in this case, 100°F. The peak energy radiated at a temperature of 100°F is at a wave length of 9 to 10 μ (0.009 to 0.010 mm). The reflectivity for radiation from a black body at 100°F (or any other temperature) is obtained by subtracting the emissivity values (at that temperature) from 100 per cent. It will be seen from this curve that the reflectivity is reduced or the emissivity increased in proportion to the thickness of the oxide until a thickness of about 0.1 mil is reached, after which the change is slower. When, therefore, an aluminum surface is to be used as a reflector for long-wave infra-red radiation, say 6 μ and longer,

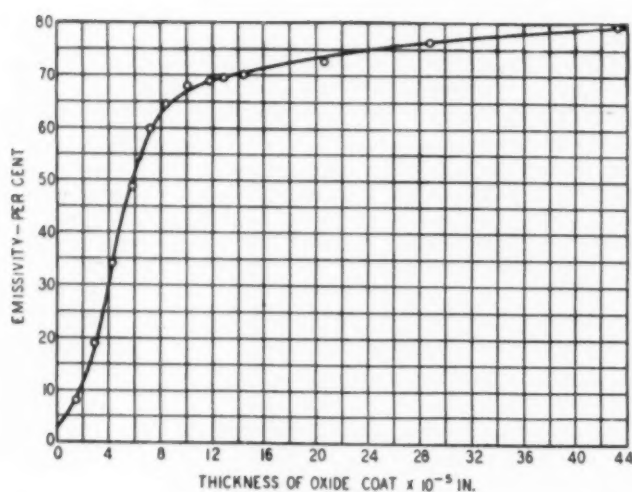


Fig. 5

Fig. 5. Relationship between emissivity at 100°F., and thickness of oxide coating.

the thickness of any oxide coat on the surface will be a factor in determining its efficiency. The fact should be borne in mind, however, that where the radiant energy comes from a fairly high temperature source, a substantial amount of the radiation may be in the visible range and in the very short infra-red range, say 1 to 3 μ , where the effect of the oxide coat in reducing reflection is a minimum. Alzak reflectors, described in a following paragraph, have proven efficient in drying with near infra-red radiation. Ickis and Haynes have published data on the spectral reflectance of Alzak reflectors which show no loss in reflectivity at 2 μ , where the reflectance was still over 90 per cent¹⁵.

The oxide coating also reduces the reflection of radiation in the ultraviolet range. For this kind of radiation, an efficient reflector should have only a thin oxide coating⁷.

The use of aluminum for reflectors has been greatly extended by Mason's discovery of the electrolytic brightening treatment, one example of which comprises treating the aluminum reflecting surfaces as anode in a dilute solution of hydrofluoboric acid^{7, 11, 19}. This results in the removal of impurities from the surface and a marked increase in reflectivity without any appreciable roughening of the surface. After this treatment the surface can be given an oxide coating of substantial thickness and protective value, but with minimum loss in reflectivity. Specular reflectors can be made by the Alzak* process, which have a reflectivity of about 84 per cent and carry a clear, glassy oxide coating of 0.2 mil or more in thickness. A process of electrolytic brightening in a solution of sodium phosphate and carbonate was later developed by Pullen²¹.

Thermal Properties

Aluminum oxide is, of course, very stable when subjected to high temperature, and oxide-coated aluminum surfaces will stand considerable heating without depreciation. Heating above certain temperatures, however, will cause crazing of the surface¹¹. The metallic aluminum base has a higher coefficient of expansivity than

* Alzak is a registered trademark of the Aluminum Company of America.

the oxide, and when the difference in expansion of the metal and the oxide becomes great enough, fine cracks result. As a rule, these cracks are almost invisible and frequently can be detected only by viewing the surface at an angle close to that of grazing incidence. Surprisingly, they also seem to have little effect in lowering the resistance to corrosion.

The temperature at which crazing will result depends upon the method of production of the coating. Generally speaking, however, temperatures of 300°F to 400°F should not be exceeded unless special processing methods are employed. With thick oxide coatings it may be necessary to keep the temperature as low as 250°F if all crazing is to be avoided. The effects of heating the oxide must be considered wherever a baked enamel is to be applied to a portion of an oxide-coated surface as, for example, when enamel numerals are to be applied on an oxide-coated automobile license plate. Consideration should also be given to the effect of the heating on the metal itself, particularly where the alloy is susceptible to age hardening.

Electrical Characteristics

Aluminum oxide is a good dielectric and some use has been made of oxide coatings as an insulating medium on aluminum. An oxide coating of 0.5 mil thickness, made in sulfuric acid electrolyte and sealed, may exhibit a breakdown value as high as 500 or 600 volts. Unfortunately, however, the minimum breakdown voltage is usually lower, perhaps 200 to 300 volts, because of the presence of weak spots in the coating. The apparent breakdown value of the coating will therefore vary, depending on whether a flat electrode of substantial contact area or an electrode with point contact is employed in measuring the breakdown voltage¹⁰. An important characteristic of the oxide coating as an insulating medium is that it is stable when heated, and does not char or give off gas as do organic insulating materials when overheated. The cost of application, however, is one factor which limits its general use.

The discussion in the preceding paragraph refers to the dry oxide coating. When aluminum is in the forming electrolyte, the voltage relationships are quite different. Current readily flows with an aluminum anode under a potential of 10 to 15 volts in sulfuric acid electrolyte, but in boric acid electrolyte the potential may rise as high as 500 volts without any appreciable flow.

Weather Protection

Some of the important applications of anodic coatings are in the structural and architectural field. The oxide coating, properly processed, offers substantial protection against the weather. Although any attack on bare aluminum surfaces is usually small and self-stopping because of the natural formation of protective oxide films, nevertheless roughening of the surface leaves it in a condition to collect dirt more readily, and dirt, where not removed, may hold moisture tenaciously and result in further attack. Smooth, hard coatings minimize surface corrosion and if dirt and dust are regularly removed by maintenance procedure, the bright, clean appearance of the surface can be maintained almost indefinitely.

The proper sealing of an oxide coating increases its

TABLE 3.
Salt Spray Exposure Test on Anodically Coated Aluminum Alloy.*

Electrolyte employed for Coating	Sealing Method	Period of Exposure to Salt Spray years	Physical Properties†					
			Before Exposure		After Exposure		Change per cent	
			Tensile Strength lbs./sq. in.	Elongation per cent	Tensile Strength lbs./sq. in.	Elongation per cent	Tensile Strength	Elongation
Sulfuric acid	Hot Water	1†	58,385	19.5	57,410	16.3	—1.7	—16.4
Sulfuric acid	K ₂ Cr ₂ O ₇	1	59,035	19.8	58,790	18.9	—0.4	—4.5
Chromic acid	None	1	58,305	19.5	54,445	13.2	—6.6	—32.

* Nominal composition of 14 gage sheet: copper 4%, magnesium 0.5%, manganese 0.5%, balance aluminum. The oxide coatings were representative of commercial coatings produced in these electrolytes and were approximately 0.4 mil thick on samples coated in sulfuric acid electrolyte, and about 0.1 mil thick on sample coated in chromic acid electrolyte.

† Average of tests on 5 samples.

‡ Exposed continuously to spray from a solution containing 20 per cent sodium chloride.

protective power. This is well illustrated by the data of Table 3, which show the effect of exposure to salt spray on the physical properties of 17S-T, which is an alloy of the duralumin type. Just as sealing with hot water improves the resistance to corrosion over that of the unsealed sample, the table shows that sealing with dichromate produces a substantial improvement over the hot water seal. This is most clearly shown by noting the per cent reduction in elongation resulting from the exposure, which was only 4.5 per cent in the case of the chromate-sealed sample, an amount which is negligible.

An electrolytic oxide coating on ice-cube trays and other containers is particularly effective in stopping any staining or darkening which might result from tap water standing in contact with the aluminum for long periods. On architectural parts, such as window frames, doors, etc., the oxide coating maintains a hard surface which is readily cleaned and maintained. On parts such as spandrels, mullions, and the like, the oxide-coated aluminum surface retains its artistic appearance over long periods.

In the aircraft field, protective oxide coatings have generally been used in combination with paint. The oxide coating renders the surface passive and resistant to corrosion, and when it is further protected by a moisture-proof painting system, the degree of protection afforded is very substantial⁸. Anodic coating in chromic acid electrolyte, or in sulfuric acid electrolyte followed by a chromate sealing treatment, is good surface preparation for a paint system comprising a zinc chromate primer with aluminum-pigmented top coats in synthetic resin vehicle, and affords good protection for thin duralumin sheet or other aluminum alloy parts⁹. The same type of surface protection may also be used on forgings and castings. In the case of castings, however, it is very desirable to bake the casting at a low temperature after oxide coating, in order to insure complete removal of moisture from any pore spaces before painting.

In general, the chemical resistance of oxide coatings is greatest in approximately neutral solutions. If the hydrogen ion concentration of the solution in contact with the oxide coating decreases to a point of appreciable alkalinity, there is likely to be attack. Strongly alkaline cleaners should not be used on oxide-coated surfaces. There is a greater range of stability on the acid side, and

except where the solution has specific solvent action for aluminum oxide (citric acid, for example), its serviceability is usually quite excellent when the pH of the solution is not below 4 or 5.

It is not practical in a relatively short article to sketch more than an outline of the properties of anodic coatings on aluminum. Enough has been said, however, to indicate the versatility of the process and to show some of its commercial possibilities. Research and development work now in progress should extend its usefulness.

References

- ¹Bengough and Stuart, Br. Patent 223,994 (Nov. 3, 1924).
- ²Bengston, H., U. S. Patents 1,869,041 and 1,869,042 (July 26, 1932).
- ³Bengston, H., U. S. Patent 1,946,147 (Feb. 6, 1934).
- ⁴Brenner, P., and H. U. v. Vogel, Influence of Structure on the Color of Eloxal Coating on Al-Mg Alloys; *Aluminium* **19**, p. 696 (1937).
- ⁵Edwards, J. D., U. S. Patents 1,946,151; 1,946,152 (Feb. 6, 1934).
- ⁶Edwards, J. D., U. S. Patent 1,946,153 (Feb. 6, 1934).
- ⁷Edwards, J. D., Aluminum for Reflectors; *Transactions Illuminating Eng. Soc.*, **29**, p. 351 (1934).
- ⁸Edwards, J. D. and R. I. Wray, Accelerated Tests of Paint Finishes on Aluminum; *Ind. Eng. Chem., Analytical Ed.*, **7**, p. 5 (1935).
- ⁹Edwards, J. D. and R. I. Wray, Painting Aluminum and Its Alloys; *Ind. Eng. Chem.*, **27**, p. 1145 (1935).
- ¹⁰Edwards, J. D., Methods of Testing Oxide Coatings on Aluminum; *Proc. Am. Soc. Test. Mat.*, **37**, Appendix II, Report of Committee B-7, p. 261 (1937).
- ¹¹Edwards, J. D., Aluminum Reflectors; *Trans. Illuminating Eng. Soc.* **34**, p. 427 (1939).
- ¹²Elsner, G., The Eloxal Process; *Oberflächentechnik* **15**, p. 139 (1938).
- ¹³Flick, F. B., U. S. Patent 1,526,127 (Feb. 10, 1925).
- ¹⁴Gower, C. H., Br. Patent 290,901 (May 24, 1928).
- ¹⁵Ickis, L. S., Jr., and H. Haynes, Drying with Near Infra-red Radiation; *Gen. Elec. Rev.*, **42**, p. 145 (1939).
- ¹⁶The Examination of Metals in Polarized Light; (Concluded on page 522)

Technical Advisors For November Issue

T. H. CHAMBERLAIN

Supervisor of
Metal Finishing,
Chase Brass & Copper Co.,
Waterbury, Conn.

CLARENCE C. HELMLE

Electrochemist
General Electric Co.
Bridgeport, Conn.

G. B. HOGABOOM, JR.

Consultant in Electroplating
and Metal Finishing,
Newark, N. J.

DR. K. SCHUMPELT

Baker & Co., Inc.,
Newark, N. J.

JOSEPH P. SEXTON

Superintendent of
Plating and Finishing
Sargent & Company,
New Haven, Conn.

When sending solutions for analysis please give following information: name and address; class of work being plated; kind of solution and volume; length, width and depth of tank; temperature of solution; current density, cleaning sequence and any other pertinent facts.

Recovering Rhodium

Q. How can rhodium metal be reclaimed from wires or plating hooks.

A. The only way of reclaiming rhodium from wires or plating hooks is to cut the wires up in small pieces and dissolve the base metal with nitric acid. Some plants have bright dip solutions which are no longer good for bright dipping but which still contain enough acid to dissolve copper or brass. The rhodium will remain as shell fragments or chips after all the base metal has been dissolved. Refiners usually have found that the recovery of rhodium from wires paid very little or not at all.—K. S.

Stained Watch Dials

Q. Will you advise us as to the cause of stains on watch dials herewith enclosed. These dials are made of high brass. They are cut down with tripoli on a leather-faced disc and then brushed by hand with a brass brush and 4-0 pumice. They are nickel plated and then plated with a 15K pink gold and finally clear lacquered.

A. The sample watch dials submitted showing a stained surface may be due to several conditions.

The cyanide gold solution should be free of iron contamination as streaky stained deposits will frequently be obtained if the solution is contaminated. The solution should be filtered before use and especially so if potassium cyanide is one of its constituents. Any addition of cyanide should be dissolved first and filtered before adding to the solution.

Iron and steel tanks should not be used for plating or rinsing as they will cause contamination. Enamel or glass-lined tanks for plating are satisfactory. Wood tanks can be used

for cold rinses, while lined steel tanks with brass or copper heating coils for hot water should be used. Linings can be of nickel, lead or any suitable alloy not subject to rust. A clean water supply is essential.

The same streaky or stained surface may be caused by a contaminated line in lacquering. Condensation of moisture in iron or steel air pipe with poor air cleaners or filters will cause trouble. Copper or brass pipe should be used if possible with efficient air filters.

Attention should also be given the air compressor so that it does not contaminate the line with both oil and water.

Another cause may be due to spraying conditions in the lacquer room. The spraying of clear lacquer should be protected from any contamination with other materials containing various pigments. Minute particles of such material will, in some instances, adhere to surface before clear lacquering and will cause a streaky stained appearance.

—T. H. C.

Plating Room Floors

Q. We are operating a plating room which is on the fourth floor of our building, and nickel, chromium, copper and zinc plating are done. The building is of brick construction and the floor is of laminated wood. We have had considerable trouble with the leaking of the plating floor which is of a mastic preparation, three or four inches thick, applied over the wood.

Will you please give us complete details regarding the preparation of a good floor for a plating room.

A. While there are several methods for the construction of plating room floors in situations other than the ground floor the writer will confine himself to two successful types with which he is familiar.

When planning a chemically im-

pervious floor in the above mentioned locations, the engineer must concern himself with the magnitude and type of vibration to which the proposed location is subjected. If the vibration, caused possibly by adjacent machinery is of high magnitude and frequency, it may be advisable to consider a type of construction which will present the greatest flexibility. Where the vibration is not large or of high frequency, a more rigid type might be installed.

In the writer's opinion, perhaps the greatest single cause for the failure of plating room floors is due to failure to sufficiently grade or pitch the surface. In some cases this has been completely disregarded. It follows logically that the longer the solutions remain in contact with a particular area, the greater will be the chemical attack up to a certain limit. If the floor has sufficient pitch, little or no time will be allowed for such a condition to arise. A pitch of about $\frac{1}{4}$ in. to the foot will give good results, provided of course, distances to the low point or drain make such a pitch practically possible. Care should be taken to maintain the decided pitch uniformly from the high to the low points so that there will be no depressions or pockets which will permit the formation of pools or puddles, in other words to insure complete draining of the floor when the room is shut down.

One type of rigid construction which has been successfully used is of reinforced concrete. The area to be covered is bounded by 5 to 6 in. angle iron or channel iron, whichever dimension is necessary to maintain 2 in. of concrete at the low point, at the desired pitch. This will function as both a form and an excellent curbing. Allowance should be made in deciding upon the size of angle or channel iron to be used, for an immediate drop of 2 in. which will facilitate the curbing effect. Having anchored the iron in place with lag screws, the area is then directly coated with hot pitch and 50 lb. tar paper is tarred in. Be sure to lap and tar all joints well. Another layer of tar and paper may be applied at right angles if desired. The entire papered surface is then mopped with hot tar and allowed to set for several days. Sand may be scattered over the tarred surface after

it has cooled, gently tamped in and the excess swept off. This will provide an excellent key for the concrete.

If the floor may be subjected to dynamic loading it might be well to use a 1:2:4 mix of concrete. When the vibration or loading is not too severe, a mix of 1:3:5 may be employed. The floor should be laid in one continuous "pour" if possible and the concrete should be of a consistency known as "quaking", and well rammed to avoid any visible stone pockets. After pouring and "screening", a mixture of 1 part cement and 1 part dry screened sand is "floated" into the surface. When the excess water has left the surface, the surface should be well troweled several times. This should give a very tight waterproof finish. The floor should be reinforced by using 6" x 6" steel reinforcing mesh.

When the cement has dried on the surface a 1 in. layer of a special proprietary mastic may be applied. The type which is laid hot has given very good results. On vertical surfaces to be finished with this material, it is necessary to imbed 1" x 1" wood strips in the concrete on 10 in. centers to provide nailing for a type of metal lath which will carry the mastic. This is generally the case with the walls of deep gutters and sumps.

It is not necessary to put down a lead pan since the tar and paper are satisfactory for this particular phase of construction. The tar and paper base may be open to criticism in that the paper does not withstand shrinking very well and may split. Subsurface waterproofing may be applied as follows. The laminated boards are directly coated with a very thin mixture of an emulsified asphalt and water. After this has dried somewhat, a second coating of asphalt of heavy consistency is applied followed immediately by an asphaltic membrane which is an asphalt impregnated cloth. The cloth is obtained in 36 in. wide rolls and so it is best to apply the second coat in a 36 in. wide strip to facilitate working on the floor. In laying the membrane, it is best to half lap the joints, that is, each succeeding strip should half cover the preceding strip. This is known as a 1-ply coating. A two-ply coating is laid exactly as was the first-ply and directly upon it.

This includes the preliminary thin coating also. It is highly important that the asphalt and membrane be brought well up and around any columns and walls present. Such precautions should be carried out as an independent operation before the floor is covered.

It should be borne in mind that every inch thickness of concrete will decrease the safe load on the floor by approximately 12½ pounds per sq. ft. This is not exact and is a maximum figure since fortunately the thickness of the slab is generally increasing due to the pitch, as the span is decreased. Nevertheless, it must be remembered that concrete construction does decrease the safe load. It is seldom realized how great a load may be exerted by a tankful of plating solution. If the tank is set on railroad ties as is generally the case, the load is not only great but concentrated.

A more flexible and lighter floor may be installed by applying two plies of the membrane described above. After laying the two plies of membrane a very heavy coating of asphalt is applied and a considerable sprinkling of sand is made, followed by very thorough tamping. The result is a very good solution-proof floor which will resist normal wear for a considerable time, and will pack harder as time goes on. Obviously the floor will have considerable flexibility. It will not, however, resist constant abrasion in one spot very long.

It should be noted that such construction does not consider pitch. This may be taken care of by omitting the second ply of membrane and after applying a heavy coat of asphalt, grading to the desired pitch with a mixture of 1 part cement, 2 parts asphalt and 3 parts sand. This should be not less than $\frac{1}{2}$ in. thick at the thinnest part. Even with this type of construction it is advisable to consider using angle iron of suitable size for the external boundaries.

The asphalt will cost approximately 90 cents per gal. A 1-ply installation will require about 5 gals. per 100 sq. ft. and a 2-ply floor would require approximately 7 gals. per 100 sq. ft. The mixture of sand, cement and asphalt will require approximately 10 gals. per 100 sq. ft. for each $\frac{1}{2}$ in. thickness of coating. Membrane will cost approximately 3

dollars per 400 sq. ft. roll, 3 ft. wide. As a safe estimate it may be figured that 6 men can lay 5000 sq. ft. of a 2-ply floor per day. Names of suppliers of water-miscible asphalt, hot mastic and asphaltic membrane will be furnished by writing to METAL INDUSTRY.—C. C. Helmle.

Corroded Plated Door Stop

Q. Under separate cover we are sending you a chrome plated extruded brass door stop which was plated about three months ago.

This item was polished, buffed, degreased and washed in a solvent. From there, it was cleaned in an alkali cleaner, 4 oz./gal., then copper flashed 1½ minutes, after which it was nickel plated for a half hour in a Watts nickel solution. They were then nickel buffed, dry buffed, chrome plated, and again color buffed.

When this item is shipped by us to the customer, it is in perfect condition, yet after being boxed and wrapped for two or three months, they begin to blister and peel along the edges, as you will notice on the sample we are submitting to you.

We are interested in knowing what the cause of the peeling is and what should be done to remedy this situation.

We are enclosing a sample of the tissue, in which they pack them, for examination. Although we doubt it, yet it is possible that some of the ingredients in the tissue may cause the trouble.

A. Due to the thin nickel deposit the sulfur from the rubber bumper is attacking the basis metal through the pores of the deposit, and causing the peeling. This action is favored by the article being confined in a wrapping. Humid conditions will accelerate the effect.

It is noted that the nickel has been cut through on the edges, and with such thin nickel, the chromium is being deposited directly through to the brass at the porous points and causing hair-line cracks.

Excessive current at the edges in the chromium plating will contribute to the defect. It is realized that a high current is necessary to throw into the recesses. However, if excessive burning is being produced at

the edges, we suggest the solution be checked. If throwing power cannot be brought up sufficiently under best operating conditions, then it will be necessary to protect high current edges with a thief arrangement.

Also suggest you check ductility of nickel deposit. Brittle nickel can be caused by impurities in the solution such as copper, zinc or lead. For method of purification consult article by L. Weisberg in the Sept. 1937 issue of the METAL INDUSTRY.

Returning to the action of sulfur, it is possible that the paper and the box contain this element in excessive amount. To check this, place about 1 gram of the paper in a flask and add 5 grams of zinc (C.P. granulated) and 100 cc of 30% hydrochloric acid. Close with a cork through which is inserted a piece of glass tubing in which is a piece of moistened lead acetate paper. Any sulfur in the paper will come off as hydrogen sulfide which will darken the lead acetate paper.—G. B. H., Jr.

Rochelle Salts in Brass Solutions

Q. Have you any information on the use of Rochelle salts in brass plating solutions?

A. Rochelle salts are not commonly used in brass solutions. Their use in bronze solutions is to promote anode corrosion, as a bronze solution has low free cyanide (in order to keep the rate of deposition of zinc low) and this free cyanide is insufficient to keep the anodes free from excessive polarization.

We have no specific information on the use of Rochelle salts in a barrel solution. If it is desired to make a trial with this ingredient, we suggest you take the bronze solution formula as given in the "Plating & Finishing Guidebook," and bring the copper-zinc ratio to 80-20, leaving other constituents the same.—G. B. H., Jr.

Statuary Bronze Finish

Q. We would like to know how to reproduce a statuary bronze finish similar to the sample herewith enclosed.

A. This finish is on brass and the following formula is given to obtain this color, using a brass base.

Cut-down buff, wash to remove buffing composition, wet scour using pumice and a soft brass wheel, oxidize in a sodium sulphide solution using about ½ oz. to the gallon of water. Use cold, then give a few dips in a solution made up of powdered arsenic 1½ lb., muriatic acid 3 gals., iron chloride 1½ oz. and water 7 gals. Rinse in cold water and oxidize again in the sodium sulphide solution; wet scratch-brush using a steel wheel, then give a few more dips in the sodium sulphide; rinse in cold water and wet scour with sea-sand. Rinse, dry out and lacquer. If bronze is used as a base, the color can be obtained without using the arsenic oxidize.—J. P. S.

(References concluded from "Anodic Coating of Aluminum" from page 519).

Proc. Am. Soc. Test. Mat. 38, Part II, p. 315 (1938).

¹⁷Keller, F., and G. W. Wilcox, Metallographic Methods for Examination of Anodically Oxidized Aluminum Alloys, Metals and Alloys, 10, p. 187 (1939).

¹⁸Keller, F., G. W. Wilcox, M. Tosterud and C. J. Slunder, Behavior of Alloy Constituents in the Anodic Coating of Aluminum; Metals and Alloys, 10, page 195 (1939)

¹⁹Mason, R. B., U. S. Patent 2,108,603 (Feb. 15, 1938).

²⁰Mason, R. B., U. S. Patent 2,115,339 (April 26, 1938).

²¹Pullen, N. D., An Anodic Treatment for the Production of Aluminum Reflectors, J. Inst. of Metals, 59, p. 151 (1936).

²²Taylor, C. S., and J. D. Edwards, Some Reflection and Radiation Characteristics of Aluminum; Heating, Piping and Air Conditioning, 11, p. 59 (1939).

²³Tosterud, M., U. S. Patent 2,008,733 (July 23, 1935).

²⁴Tosterud, M., U. S. Patent 2,018,388 (Oct. 22, 1935).

NOTE: The date given for a patent is the issue date which is later, of course, than the filing date and the date of discovery.

METALLURGICAL DIGEST

SELECTED ABSTRACTS ON CASTING—ROLLING—PHYSICAL METALLURGY

The Influence of Microstructure Upon The Process of Diffusion in Solid Metals*

An Extended Abstract by

Francis J. Rooney

Chemical Engineer, G. E. Co., Bridgeport, Conn.

The subject matter is treated under three divisions, the structural changes accompanying diffusion, the anisotropy of diffusion, and intergranular diffusion.

Structural Changes Accompanying Diffusion

Polycrystalline copper was heated 150 hours at 400° C with chips of 65% zinc, and 35% copper. Upon examination, it was found that columnar grains of gamma and of beta brass were formed. Ordinarily, the individual crystals extend across the new phase but when the rate of formation of the new phase is greater than the rate of growth of the crystals, an equiaxed grain structure is produced.

During the diffusion of zinc into alpha brass, grain growth, recrystallization, and twinning were found to take place.

Samples composed of two copper crystals with a mutual boundary were heated with 70-30 brass chips one week at 775° C. Upon examination, it was found that the two grains grew into each other alternately in long narrow bands. Evidently, the zinc in penetrating into the copper lattice had distorted it sufficiently to cause grain growth. This phenomenon was only found, however, in those samples having a single grain boundary which was nearly parallel to the direction of the zinc penetration. New crystals were found at the corners and in some samples at the original grain boundary. This was evidence of recrystallization caused by diffusion. Some photomicrographs showed several annealing twins which terminated at the boundary of the recrystallized grain. These twins must then have formed late in the diffusion treatment or it is possible that they were formed during the slow cooling from the diffusion temperature. Another example of twin formation was found in a single crystal of zinc which had been electroplated with copper and diffused at a temperature of 300° C.

When a solute that expands or contracts the crystal lattice of its solvent is diffused, a state of stress may be set up between the zone of solute penetration and the undisturbed zone. The diffusion temperatures are well above the recrystalliza-

tion temperature; therefore, the conditions of stress and temperature required for grain growth and recrystallization are present. The distortion caused by the diffusion of one metal into another varies for different metals. In all cases of diffusion, sufficient stress is not set up to cause recrystallization. For instance, no microstructural change was found in samples of iron into which chromium was diffused below the A_3 temperature or in samples of iron into which nickel was diffused above the A_3 temperature. The addition of 68 atomic per cent of chromium expands the lattice parameter of iron by only 0.011 Angstrom units and 39 atomic per cent of nickel expands it 0.025 Angstrom units, but the addition of only 24 atomic per cent of zinc increases the lattice parameter of copper 0.061 Angstrom units. The volume change caused by diffusion of zinc into copper was large and recrystallization took place but in the iron-chromium and iron-nickel couples, where the volume change was much less, no microstructural change was observed.

It is reasonable to suppose, then, that there is a limit of stress below which no microstructural change will take place. The greatest change will also be found in the early stage of diffusion when the concentration gradient is steep, and less change will be observed as the diffusion progresses and the gradient becomes less steep.

Anisotropy of Diffusion

The effects of an anisotropy of diffusion are more evident when a solute is diffused into a single crystal, a single layer of crystals, or into a polycrystalline aggregate having a preferred orientation of its crystals. The effects are not found if the solvent metal is composed of randomly oriented crystals. An anisotropy of diffusion has been observed on many occasions in non-cubic metals but only recently has it been observed in the cubic system.

The present authors have made a study of the anisotropy of the diffusion of zinc in alpha brass. Three samples were machined from a cast single crystal of pure copper. The end faces of one sample lay nearly in the cube plane (100) of the copper crystal, those of the second in the octa-

hedral (111) plane, and those of the third in the dodecahedral (110) plane. After annealing to remove all stresses which might have caused recrystallization, the samples were placed with 70-30 brass chips in an evacuated and sealed silica tube and kept at a temperature of 775° C for one week. The ends of the samples were turned off to a measured distance and analyzed. Concentration-penetration plots for the three samples showed that at low zinc concentration, the diffusion had proceeded most rapidly in the direction perpendicular to the dodecahedral face of the copper and least rapidly perpendicular to the octahedral face. At high zinc concentrations, however, there was little difference in the rates of penetration.

The samples were also polished, etched and examined under the microscope. This examination showed very little difference in the widths of the bands. This is reasonable because the depth of the etch was about 0.2 mm at which point the penetration depth curves are very close together. The experiment has shown that an anisotropy of diffusion exists in the copper-zinc system and that the anisotropy depends greatly on the concentration of the solute.

Samples of pure iron into which chromium, nickel, nitrogen and carbon respectively were diffused did not show, upon microscopic examination, any influence of crystal orientation upon the rate of diffusion. The phase transformation and volume changes which take place when these alloys cool make it difficult, however, to ascertain the structures which existed at the diffusion temperature.

Intergranular Diffusion

It is generally believed that the rate of diffusion depends greatly upon the size of the grains of the solvent metal. Numerous experiments have been made to prove this point. The diffusion of most metals seems to proceed more rapidly in a solvent metal having fine grains. It is a common belief, nevertheless, that this is not true in the iron-carbon system. The present authors, however, have conducted an experiment which shows that carbon does diffuse more rapidly into a steel of fine

(Concluded on page 559)

*A paper by F. N. Rhines and C. Wells, Trans. Amer. Soc. for Metals, 27, p. 625, (1939).

ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—FINISHING—RUST PROOFING—LACQUERING

Patents of Interest to Electroplaters

By Joseph B. Kushner, Ch.E.

Producing Etched Surfaces on Aluminum. U. S. 2,168,909. August 8, 1939. Granted to R. B. Mason. Assigned to the Aluminum Co. of America. The invention relates to the production of bright etched surfaces on aluminum, particularly the production of uniform reflecting surfaces. Ordinarily, in order that uniform etching of aluminum takes place in hot sodium hydroxide solutions, the aluminum must contain a small percentage of copper from 0.1-0.2%. With less copper present, the etch becomes non-uniform and streaky. The invention overcomes this difficulty inasmuch as with it, pure aluminum can be etched to a uniform finish. According to the patentee, when certain metal salts are added to a caustic etching solution, the aluminum surface produced in it is substantially free from streaking. Either the salts of copper or cobalt are satisfactory. A typical formula is:

NaOH (5%) 100 gallons
CuSO₄ ½ lb.
NH₄OH 3 lbs.
Temperature 140° F.
Time of etch 3 minutes.

On coming out of this etching bath, a dark film appears on the aluminum. This film is removed by dipping the work into 50% nitric acid, washing and drying. The nitric acid uniformly removes the dark film, which is no doubt a copper film, exposing the perfectly etched aluminum underneath. If the etch bath is used over long periods of time, the metal compound must be replenished as well as the ammonia content. The time of etching depends on the amount of surface impurities present.

Calcium Sulphate Used For Removing Excess Carbonates From Cyanide Plating Baths. U. S. 2,164,924. July 4, 1939. Granted to R. O. Hull. Assigned to E. I. du Pont de Nemours Co., Inc. Cyanide plating baths gradually build up in carbonates due to the reaction of CO₂ from the air with the cyanide as well as from the oxidation of the cyanide itself. Excess carbonates reduce plating bath electrode efficiencies and narrow bright plating ranges of many baths. Carbonates are expensively removed by use of barium cyanide, inefficiently removed by freezing. The patentee claims that CaSO₄ when added to a cyanide bath precipitates calcium carbonate in the bath, leaving harmless sodium sulphate in solution. Most of the carbonates are thus removed. An example of a cadmium plating bath containing 75 grams per liter of sodium carbonate to which 120 grams per

liter of calcium sulphate were added is given to illustrate its action. After the addition and stirring for an hour and a half, the carbonates are reduced to 5.4 grams per liter. Slightly more calcium sulphate should be added than is actually needed according to the stoichiometric equation of the reaction and the mixture should be stirred well. If it is desired to remove the sodium sulphate, should it be in excess, cooling will result in its crystallizing out. The precipitated carbonates can be removed by shoveling out, filtering, etc.

Electrodeposition of Aluminum. U. S. 2,170,375. August 22, 1939. Granted to F. C. Mathers and R. D. Blue. The patent describes a method and gives bath formulae for electroplating with aluminum. The aluminum is deposited from an anhydrous benzene, benzene derivative, aluminum chloride bath. The temperature is about room temperature and aluminum anodes are used. A supernatant liquid sprayer of benzene protects the bath from absorbing water and prevents oxidation, and moisture hydrolysis. Benzene, toluene, xylene, etc. are all suitable for use in the bath. A typical formula is:

Benzene 88 parts by weight
Ethyl bromide 57 " " "
Aluminum chloride 20 " " "
Temperature 20° C.
Current Density—1.55 amperes per sq. dm.

This bath gave good results, plating aluminum on various other metals, 8-10 hours a day, for 3 months. It is necessary to add ethyl bromide from time to time as the anode efficiency exceeds the cathode efficiency. Aluminum alloys may be plated as well as aluminum if an alloy anode is used or separate metal anodes are used alternately.

A Method for Making Metal Covered Gaskets. U. S. 2,164,764. July 4, 1939. Granted to Walter Claypoole. Assigned to the Texas Co. A method for making metal gaskets. Asbestos fibre gaskets are soaked in paraffin and dusted with graphite powder. After plating with a suitable metal in a standard plating bath, a few small holes are made along the edges and the gasket is heated so that the paraffin melts and runs out. The holes are then sealed with solder.

Process and Bath for Cleaning Metals. U. S. 2,165,852. July 11, 1939. Granted to

J. Harmon and D. M. McQueen. Assigned to E. I. du Pont de Nemours Co., Inc. In the pickling of ferrous metals organic inhibitors that are really efficacious in action are generally very expensive as they are difficult and costly to prepare. An efficient pickling bath making use of a complex phenol-formaldehyde-ammonia resin is described. A typical formula is:

Sulphuric acid
(5%) 100,000 parts by weight
Resin complex 5 " " "
Temperature 180° F.

The resin, according to the patent, makes an efficient and inexpensive inhibitor, preventing acid attack on the bare metal but permitting the acid to dissolve off the oxides.

Chemical Plating. U. S. 2,168,638. August 8, 1939. Granted to D. C. Wilkerson. Assigned to General Motors, Inc.

This consists of a series of formulae and the method for impregnating fibrous material such as cloth or paper with a combination cleaning and plating compound. The said fibrous material can then be used for cleaning and plating metallic objects such as headlight reflectors, etc. Several formulae are given among which are:

Silver, cleaning and plating.

1. AgCl 2 parts by weight
CaCO₃ 3 " " "
NaCl 2 " " "
K₂CO₃ 4 " " "
2. AgCl 1 " " "
Argol 2 " " "
NaCl 2 " " "

Tin, cleaning and plating.

1. Stannous chloride, 2½ parts by weight
Cream of tartar .. 4 " " "

The applicator must be kept hot. Zinc dust or filings added to the mix increase the plating efficiency.

Gold, cleaning and plating.

1. Gold chloride 1 part by weight
Potassium cyanide 2 " " "
Mixed to a paste with
Water 3 parts by weight
Whiting (CaCO₃) 3½ " " "
Cream of tartar .. ¼ " " "

The cloth or paper applicators must be dampened before being put into use.

Apparatus for Plating Articles Such as Tacks, Buttons and Jewelry. U. S. 2,164,710. July 4, 1939. Granted to F. A. Hatch. Assigned to D. B. Gurney Co. Apparatus consists of an open topped trough through which the articles are passed into a tank containing the electrolyte.

Post Scripts

Tales from the Newark Outing

Threatening skies all morning preceding the meeting, kept the attendance down, but those who were courageous enough to attend, were favored with good weather, good fellowship and good food.

The members were greeted on arrival by Chef Horace Smith, shown in the photograph below, who was ready to serve his special hamburgers. George Reuter was the Maitre-de-Beerkeg, and served the customers long and faithfully throughout the day.

No picnic would be complete without a thrilling baseball game, and Bill Newbery's Wild Cats were defeated 10 to 6 by Bob Pecoraro's Mud Cats. Ye Editor retired in the first inning as umpire amidst aspersions from Oakite's Everett Ward,

Gleanings from Leacrest Party

The meeting hall was found to be remodeled with ample accommodations for several hundred. The meeting was the largest ever with 180 being present.

The festivities were late in starting as almost everyone was listening to the radio to hear the Yanks beat Cincinnati, Yale beat Columbia, and how Army came from behind to beat little Center College of Kentucky.

"Detrex" Dave Willard of Detroit, was on hand to meet his old buddies and "Maizo" G. D. Brown came from Circleville, Ohio, to see what Yankee platers look like in moments of relaxation.

Tom Chamberlain, Joe Downes and Bob

nial athlete, shortstop, and Carl Schaefer, 3rd base.

Bill Newbery, fresh from his baseball triumphs at the Newark outing, called them as he saw 'em. Hank Kellner was official Heckler.

The stories which we heard will have to be printed in "Whiz Bank."—Sorry folks.

The Gillette foursome, Andrew Garrett, Louis Gale, John Cunningham and Walter Ryan drove in from Boston.

Joseph Sheridan, Acme Shear Company, said he reads M. I. from cover-to-cover. Thanks for them kind words, Joe.

Jack "Wyandotte" English must know the right people in Connecticut to get a



Chef Horace Smith ready to serve all comers.

such as "the guy don't know what its all about," and the decisions of the balance of the game rested on the side which yelled the louder.

Bill Finder played first base in a professional manner, while the catches of Johnny Gumm and Capt. Pecoraro, brought the crowd to its feet ever and anon. The 6th inning was featured by John Kotches' spiking of the 2nd baseman and the slapping of a 2-base hit by Ralph Liguori's youngster.

Bill Kennedy, who misses almost none of the meetings, was on hand.



Some distinguished spectators watching Bill Newbery's Wildcats being defeated by Bob Pecoraro's henchmen. Left to right, Honus Wagner, Bill Kennedy, Frank MacStoker, and Ralph Liguori.

Mooney arrived late after attending Joe Sullivan's entry into connubial bliss.

Bob Gray, Secretary of the New Haven Branch of the A.E.S. leaves Waterbury Buckle Company to go with H. C. Cook Co. of Ansonia.

Platers Beat Peddlers 8-5

Capt. A. Dehle's Peddlers, evidently footsore from calling on the Pummeling Platers, were defeated in the closing innings by Ed. Jackson's home run. G. Stewart Krentel, Peddler pitcher, was given masterful support by Bob Sizelove, catcher; Maxie Kraft, 1st base; Carl Johnson, 2nd base, and Lionel Cinamon (who was robbed in 6th inning of a close put-out.)

For the Platers, Charles Nardozi was pitcher; William "Casco" Ehrencrona played 2nd base; John Ed. Charleson, the peren-



Capt. Newbery smiles even in defeat. Note the Ananias Club badge.

car license with just his initials.

Al "Bias Buff" Yohe batted 1,000 at the hamburger stand.

Colin Hastie was forsaken by his Westinghouse pals, Derick Hartshorn and Art Wood, and when we last saw Colin (at 10:30 P.M.) he was wondering if he was strong enough to walk to Springfield. Our informers reported later that Clinton Goodwin went to his rescue.

Harry MacFadyen of Arrow-Hart and Hegeman, was on deck. Harry has been seriously ill for the past two years, but is now able to work 4 or 5 hours daily.

Los Angeles' Merrymaking

The annual picnic of the Los Angeles Branch of the American Electroplaters' Society was held at City Park, Montebello, Calif., Sunday, October 8, beginning at 10 a.m., with approximately 100 persons attending, including members of the society as well as their families and friends.

The picnic committee, headed by C. C. McClaren and ably assisted by Earl Coffin, C. E. Thornton, Bruno H. Schindler and Harry J. Kroesche, prepared a well-balanced program of entertainment and games, so that, literally and truly, "a good time was had by all." A feature which won the unstinted approval of all who attended was the total absence of speeches and anything that smacked of business.



A waitress at the meeting, seeing the snapshot of Past President M. D. Rynkofs, promptly nick-named him "Sitting Bull." It caught on with his friends at the meeting, and Rynkofs, it appears, will be Sitting Bull to his associates for some time to come.

The athletic events included foot races, three-legged races for men, women and children, a cracker-eating race, and a pastime which started out as a soft-ball game, but deteriorated into old-fashioned rounders, with any number of players, from 12 to 20 on the side as the "game" proceeded. Upon the advice of President Ray Bray, acting for the "good of the society," the scorekeeper refused to divulge the final score. The 50-yard dash was won by Stanley Rynkofs, son of Past President M. D. Rynkofs; the tug-o-war by the team anchored by D. N. Eldred, the 230-pound Pacific Division representative of the E. I. du Pont de Nemours and Co.; the three-legged race by Stanley Rynkofs and Walter Oliphant; and the cracker-eating race by the three-man team composed of President Ray Bray, Secretary Raymond Sullivan, and C. E. Thornton. The latter race was somewhat of a scientific affair, involving both speed of foot and the ability to absorb a

quantity of crackers without the hydraulic assistance of drinking water.

Excerpts from the Diary of an Amateur Sailor

Three days were spent tossing around in Chesapeake Bay with a Baltimore friend and our families, with some of the time in a Southeaster. It was hard for us to sleep because we could see almost nothing at times, and thus we were conscious of impending disaster at all times, and also perhaps because neither the Mrs. nor myself uses liquor.

The ship was steered most of the time by the captain's 11 year old son who has a cap and full regalia but who seemed to require considerable nautical advice from both his mother and father and, indeed, much of the time there was a triangular argument as to whether certain flashing buoys were or were not such ones as on the chart. Usually the child turned out to be right.

When we got into the wrinkle of big ships, lamps, pitchers, radios, and glasses of stimulants began to toss around, I tried standing amidships and flexing my extremities to accommodate these ups and downs. Our boat had been exposed to severe hot weather during the past summer, and some of the corners on the deck cabin had developed small leaks which were quite disgusting. There was one, for example, which came down the galley stove pipe and dropped on several areas of the stove, which were quite the very ones most useful for cooking. These drops were sepia black and they spattered around the polished cooking utensils.

Lillian (that's the Mrs.) left one of her choice suitcases on the bunk—we had a stateroom in the bow with twin bunks—directly under an open porthole. This hole had a ventilating scoop in it which was a satisfactory arrangement until the wind suddenly changed—and, lo! the result was disastrous, to say the least, to her finery in the open bag!

During the night (first one) we rode out a sort of imitation hurricane down in Middle River Bay, that I now consider in retrospect, an experiment in strength of materials, to determine the resistance of canvas, varnish, copper-screen, rope and anchor-rope to weather, and the play of the elements.

The "crew" had a "room" in the foremost forward section. He disappeared down there, turned on his radio to hot-jazz and kept out of sight. (I felt that he was using much of his spare time in prayer from one or two remarks he made to me, when the Captain was out of sight.)

'Twas interesting to note the kinds of accommodations they seemed to provide on this boat. Near our cabin was a bathroom with a certain-sized but regular-shaped tub and a button to press to empty it by legerdemain. It worried me to think of pulling the plug in such a thing, situated as it was in the bottom of the hold, so I made believe I didn't really need a bath, although this was an exaggeration, no doubt.

Then there was the continuous shudder of the craft and the tremor of the big diesel

and all the various pumps and generators in the engine room, which gave us pause, or at least quite stopped all of our normal secretions and thoughts.

To keep the cabin nice and warm, Rastus Washington, our engineer, kept the engine room door open and the oil fumes made us cry—and the din thereof was truly alarming, with the door open, so finally Rastus shut it, and I personally appeared unto him and gave him a silver coin as a keepsake, (at least until he passed a saloon on land).

He served a sort of mixture to the other guests that made them more than ordinarily lackadaisical, which I observed was composed in large part of essence from a vial marked "Seven Crowns." I had also noted there were bottles marked with various prescriptions all probably of quite common knowledge among seamen and one called "Reserve" by some Calvert Bros., which the crew seemed to serve principally to himself. I assumed it was reserved for use of the help. The crew also astonished me at times by his drinking a perfume called "Four Roses."

By the time we got back up Baltimore Harbor, I had learned how to come up to port when a liner is bearing down on one—"dead ahead"—and of the nervousness attendant on steering a ship's nose right at another's for some minutes, without giving her any notion which course we have in mind taking. I learned to dock and undock—to unfoul an anchor, and to work the device that they have in the bath-rooms that makes use of a foot and both hands—for a substitute for the simple ball float we have at home.

Rastus played the piano quite a good deal. Occasionally, Cleopatra, our hostess, would interrupt him in his reveries to say that Ulysses was considerably outside the channel buoys and the chart said there was about 5 ft. of water at this point and would Rastus "for God's sake take the wheel," and get from Rastus, the cool suggestion that the conventional practice in such cases was to head for deep water at the earliest convenience.

The best part of the whole voyage was cleaning up the ship to leave her after the ladies had disembarked. This took hours but it was quite restful and uneventful. We spread more canvas over the deck house, took in the various loose flags and tackle; repacked luggage, wet and dry; ate or threw overboard, all left-over foods; left refrigerator open to air out; made boat fast to dock about eight ways and plugged in the light on the mizzen mast. That was a party!



Walter "Pepys" Bullard, Beverly, Mass.

Walter R. Meyer

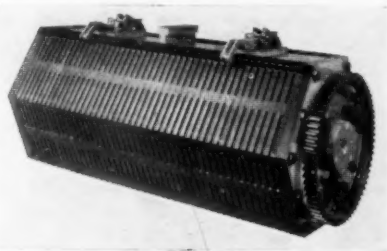
NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Laminated Rubber Plating Cylinders

A new type of plating cylinder made of molded rubber sections rigidly held by steel support ribs on 4" centers has been announced by C. E. Huenerfauth, chief engineer of the Crown Rheostat & Supply Co., Chicago, Ill., who describes it as follows:

"In this new Crown laminated cylinder, by departing from stereotyped design, we have in place of the $\frac{1}{4}$ " panels, $\frac{3}{4}$ " sections which give three times the amount of material for wear than normally provided by the old-fashioned panels. Thus much longer wear is assured. Since the cylinder construction is much more rigid as well as three times thicker, it is fair to predict that the lasting qualities will be much more than three times greater.



Laminated rubber plating cylinder.

"As so often happens when a sweeping change is made in customary design, further advantages are gained," declared Mr. Huenerfauth. "The most important additional advantage is that the slot openings are claimed to allow a much greater flow of solution through the cylinder than the former round perforations. This means that the plating operation is greatly speeded up without increasing the size of the cylinder.

"Another advantage gained by the slot design, is that the slot openings can be adjusted down to $\frac{1}{16}$ ", standard openings are $\frac{1}{4}$ ", $\frac{1}{8}$ " and $\frac{1}{16}$ ". Manual cleaning is much easier with the slots than with the panel construction."

Repairs are said to be easier to make as new sections can be easily slipped into position. Cylinders are practically impervious to alkali solutions and sections which are heavily corrugated are said to greatly aid in turning over the work.

New Smut Bath

Special Chemicals Corp., 30 Irving Place, New York City, have developed a new bath for applying antique or oxidized effects to metals.

The smut produced from the bath may be easily relieved, and after final finishing, hardens permanently for lasting beauty, according to the manufacturers.

The bath is operated at approximately 180° F., in ceramic containers using cold rolled steel anodes. The work to be coated with smut is cleaned in the usual manner, and then plated in the smut bath from 5 to 20 seconds, depending upon the material and the depth of tone desired, using about 6 volts.

The work can then be easily relieved by hand, wheel or burnishing, using sodium bicarbonate, either wet or dry. After the work is well rinsed, it is then given a final plating of gold, copper, brass or any other desired metal.

Further information and literature can be obtained by writing to Special Chemicals Corporation.

White Chromium Plating Process

Many firms are now actively studying the possibilities of white chromium solutions because of the savings of plating time, much better throwing power (Dr. Pan's cavity scale test instrument shows, it is said, 55% throwing power whereas ordinary chromium solutions show only 30%), much lower current densities and resultant improved plant production.

A wider bright plating range along with lower current densities reduce burnt edges and rejections. White chromium is stated to be free from the usual bluish or purplish tints of conventional chromium plate and possesses a whitish color similar to that of platinum and white precious metals.

The white chromium also claims to be flexible, resistant to peeling and non-tarnishing.

It is reported that other concerns are investigating the promising possibility of white chromium for barrel and basket plating which would result in unprecedented savings as a consequence.

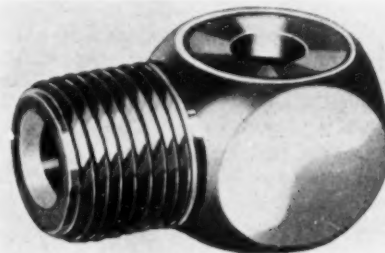
The conversion of ordinary chromium solutions to white chromium solution is recorded to be a simple matter, requiring mere addition of a special compound called

"Triskalite," to the original solution under certain conditions. White chromium solutions can be easily operated and maintained by any chromium plater.

White chromium is available to the plating industry from the Triskalite Corp., 67 Wall St., New York City.

Spray Nozzles

The Spraying Systems Co., 4922 W. Grand Ave., Chicago, Ill., has placed on the market a non-clogging spray nozzle, called "Whirljet Simplex." The spray is the hollow cone type with uniform distribution.



Whirljet spray nozzle.

The nozzles are available in $\frac{1}{8}$ ", $\frac{1}{4}$ " and $\frac{3}{8}$ " male pipe connection. Capacities range from 0.1 to 2.5 G.P.M. at 10 pounds pressure. The standard stock construction is brass; other metals can be specified.

These nozzles are recommended for air conditioning, roof cooling and chemical processes, or wherever a low-priced, non-clogging centrifugal type nozzle of one piece construction can be used.

Black Plating Process

A new black plating process has been developed by E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.

The new process is described as producing lustrous, deep black electrodeposits superior in color to any before known. It is based on a combination of molybdenum and nickel, available in plating salt form. Deposits are sufficiently black to escape

Professional Directory

G. B. HOGABOOM, JR. & CO. Consulting Chemical Engineers

Solution analysis, plant design, process development. Testing of deposits—composition, thickness, porosity, salt spray.

352 Mulberry St. Newark, N. J.

J. B. KUSHNER, B.S., Ch. E. "Personalized Plating Service"

Plating bath analyses made on your premises. Installations. Advisory service.

20 Eldridge St., N. Y.
ORchard 4-8015

color refraction under an intense beam of light in a dark room. The process operates, it is said, at a high rate of deposition at low current densities, twenty times more rapidly than nickel under identical conditions. Its throwing power is said to be higher than any other plating system, giving deposits of uniform thickness even in deep irregular recesses.

Projected uses cover a wide range, among them electrical accessories, instrument dials, office furniture, lighting fixtures, flashlight cases, automotive hardware and trim, hinges, furniture hardware and stoves. An important application is seen in optical instruments, such as microscopes, cameras and telescopes, where a true black finish is necessary. The firm states that it is applicable to bases of zinc; aluminum; cadmium electroplated on brass, iron or steel; tin, either electroplated or hot-dipped; nickel, and steel or iron. An unusual characteristic of the new black process, it is stated, is its ability to plate directly over aluminum prepared only by cleaning in an alkaline bath.

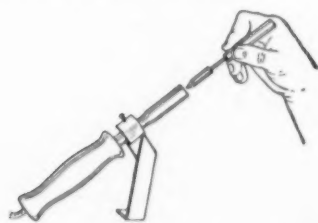
The coating is claimed to work well over any of the suggested base metals, particularly as a decorative finish for indoor use. For outdoor use, the black plate should be deposited over an undercoating of cadmium, after which it should be lacquered. Deposits produced by the new process are of low density, with a maximum thickness of about 0.002".

Du Pont has designated the process as the "Moly-Black" molybdenum-nickel electroplating process.

A New Pencil Iron Unit for Fine Soldering

In recent years, there has developed a need for smaller soldering irons of the pencil type. Small radio sets with limited working space, fine connections on electric appliances and similar work have brought out the definite need for smaller soldering irons than those available.

Manufacturers of electric soldering irons have endeavored to solve this problem by making smaller soldering irons. These have not worked out satisfactorily.

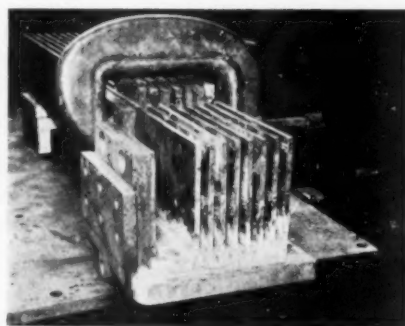


The Electric Soldering Iron Co., Deep River, Conn., states that it has solved this problem in a most unique and satisfactory manner. By using a regular "Esico" No. 54P or No. 96P soldering iron, fitted with a bracket to hold the iron on the bench, with a pencil iron inserted in the place of the regular tip ordinarily used, they are able to meet this demand for smaller irons with suitable means for heating. The unit heats the pencil iron quickly and, it is recorded, keeps it at the proper temperature for instant use.

Brazing Copper Conductor Arms with a Silver Alloy

The use of low temperature silver brazing alloys for joining heavy copper current conductors is growing rapidly. Recently the trade papers have described a number of bus bar applications as used on electroplating installations and in the power plant.

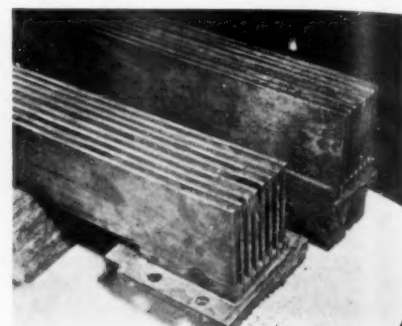
A similar application is now being used by Sperry Products, Inc., in building rail



The completed braze before cleaning off flux or finishing.

welding equipment. The current conductor arms, an important part of this welder, are made of copper bars $\frac{1}{4}$ " thick by 6" wide. They are brazed to a copper casting with a brazing alloy containing a medium percentage of silver, which flows freely at 1175°F. This alloy was selected for this application for four important reasons. (1) It makes joints which are ductile and high in tensile strength. (2) The electrical conductivity of the joints is as high as or higher than the copper itself.

(3) Joints of solid metal cannot oxidize and never require cleaning or servicing. (4) The free flowing silver brazing alloy goes into the joint, little stays outside, little or no finishing work is needed. The conductor arms on this job are inserted in slots, $\frac{3}{4}$ " deep, milled in the copper castings. A low temperature flux was used which is fluid and active at 1100°F.



The finished joints. Note the sharply defined, clean joints.

The rail welder, a recent development by Sperry Products, Inc., joins railroad rails permanently into long lengths. Rails of standard 39 ft. length have been welded to form lengths of 1700 ft. and these lengths in turn have been welded together. The longest stretch measures 7700 ft. and is located near Schenectady, N. Y. out in the open (not in a tunnel) where it is subject to extreme variations of temperature and shows how the forces of expansion and contraction have been overcome.

Three Face Shields in One

The Boyer-Campbell Co., 6540 St. Antoine St., Detroit, Mich., has announced the development of a face shield which is claimed to contain three types in one. It has been made practical with a complete interchangeability of parts, and the screen, fibre or "plastacele" guard may be quickly buttoned on at the option of the wearer.

When fitted with "Plastacele" window (clear, light, medium or dark green and amber), it is said to be ideal for spot, flash and gun welding, buffing, polishing, wire brushing, die casting, flying scale, etc. When fitted with wire screen win-

dow, it is recommended for use for babbitting, heat protection, etc. Fibre front and glass holder claim to give the wearer complete protection for acetylene welding, burning, scarfing, etc.

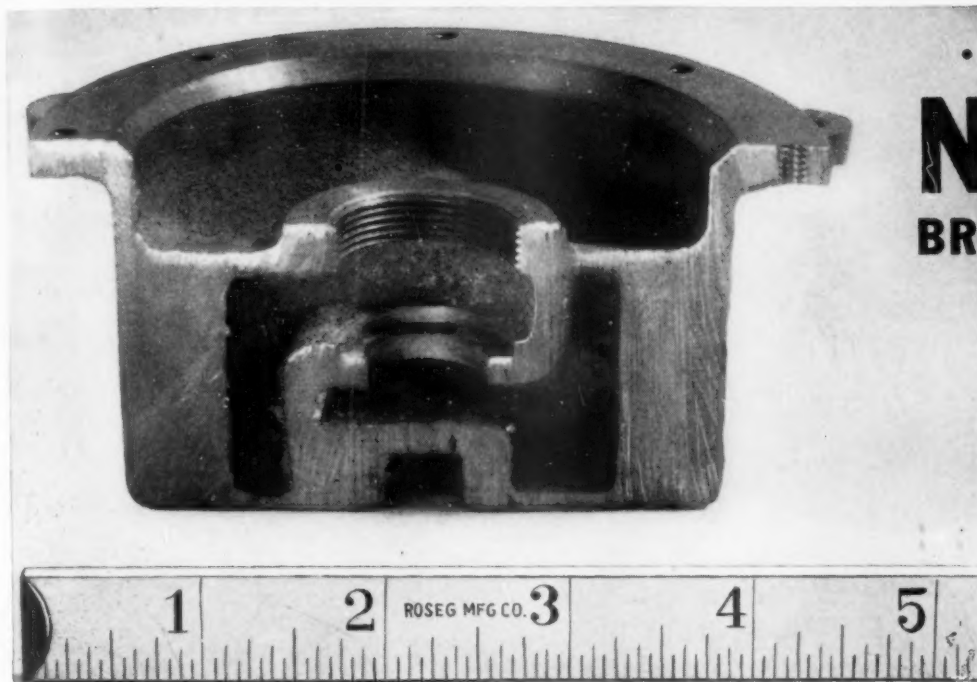
The windows are buttoned on the spark deflector (fibre forehead guard). Absorbent real leather sweatbands, backed by wool felt, keep perspiration out of the eyes. These windows are aluminum bound to permit individual fitting to suit the wearer. and with equal protection, with or without correction glasses. When not in use the window can be tilted upward and in that position protects from overhead glare.



Three-type face shield.

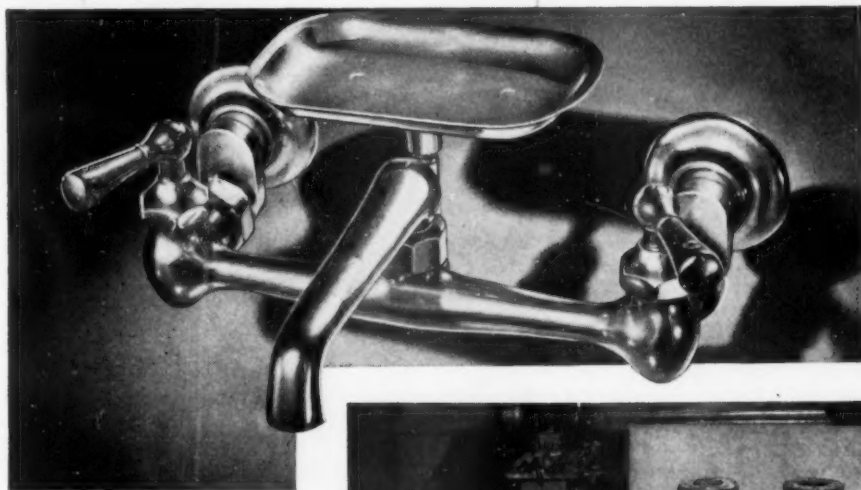
PRESSURE LEAKS and CASTING LOSSES

PLUGGED



...by using
NICKEL
BRASS—BRONZE

Unusual variations in section thicknesses are mastered by adding 1½% Nickel to red brass compositions. Nickel increases fluidity, aids uniformity in thick and thin sections, minimizes porosity — thus plugging losses on rejects. This pressure-tight check valve — halved here for inspection — was cast by the National Bronze Co., Springfield, Mass., from 1½% Nickel brass.



Using an all-scrap base, the Universal Brass Mfg. Co., Los Angeles, cut foundry losses from shrinks and cracks 90% by adding 1% Nickel to sink fixture bronze. Nickel reduced porosity; and induced perfect forming of intricate patterns. Put Nickel to work for you!

To make water meter bodies stand 225 lbs. pressure, F. H. Koretke Brass and Mfg. Co., New Orleans, modifies their "G" bronze mixture with 1½% Nickel. Nickel reduces grain size, assures pressure-tight castings. Uniformity of dense-grained Nickel alloys assures easier machining, and saves on shop costs.



THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.



The Buff of Today for the Work of Today

BIAS Buffs are designed to meet all buffing requirements, in any finishing department where buffing is done—and do a better job than any ordinary buff.

These buffs are made of selected cloth from our own mills. This cloth is formed in the buff so that it cannot waste or ravel.

The construction of Bias Buffs is the best, yet the cost is less than the ordinary buff when wear and service is considered.

BIAS Buffs will do your work of today better. Why not try them?

BIAS BUFF & WHEEL CO., Inc.
428 Communipaw Ave. Jersey City, N. J.

New Bushing for Grinding Wheels

The V.D.B. (vibration dampener bushing) resilient mounting for portable grinders is a new feature being incorporated in grinding wheels manufactured by the Manhattan Rubber Mfg. Division, Passaic, N. J.

Application for a patent has been made for this development which is said to offer several advantages over regular lead bushed wheels.

Tests made by the manufacturer have shown that use of the V.D.B. mounting, which requires no changes in existing

equipment, claim to increase grinding wheel life, and machine maintenance costs are said to be greatly reduced with a better grinding finish. It is also reported that the mounting makes possible increased operator efficiency, a minimum of vibration and less fatigue.

Stripper

A new development for the stripping of the high baked enamels, paints and lacquers from metals, has just been released to the trade under the name "Metastrip" by the Estox Products Co., 157 Brewery St., New Haven, Conn.

The manufacturer states that Metastrip is entirely new in theory and especially designed to strip the latest finishes. In a laboratory test, the products of several well known manufacturers were stripped cleanly in two minutes or less. This was accomplished without harming the metal by etching or other discernible effects, it is claimed.

Application is by immersion in liquid Metastrip which is heated to about 130°F. The action is by floating the finished surface away from the metal. It is reported that continuous use of the same material, plus additions from time to time to maintain the strength, allows for economical operation, and does not require special equipment, claiming to be easily used, non-inflammable and not injurious to the hands.

Cushion Pad for Goggles

A comfort cushion pad has been developed to alleviate the discomfort of wearing goggles on industrial operations such as pre-heating, metal pouring, relining open hearths and heavy gas welding and where the intense heats are conducted



Cushion pad for goggles.

to the wearers face through the eye cups of molded plastic goggles. This cushion pad, molded from soft sponge rubber fits over the eye cups of Cesco chipping and welding type goggles. The rubber pad insulates the plastic goggles from the wearers face, preventing blister and burns. When snapped over the eye cup, the elasticity of the rubber holds the pad securely in place without cementing or sewing. Pads can be sterilized and are readily replaced when necessary. The Chicago Eye Shield Company, 2300 Warren Boulevard, Chicago, Illinois.

Solvent and Rust Preventive

A solvent that combines soap and water detergency with the solvent performance of benzines has been announced by A. F. Curran, research and development chemist for the Curran Corporation, Malden, Mass.

The new solvent, according to the Development Laboratory, is clear in appearance, highly penetrating and non-inflammable. Small metal parts, stampings, extruded shapes or die castings immersed in the solvent, assume a scoured appearance with-

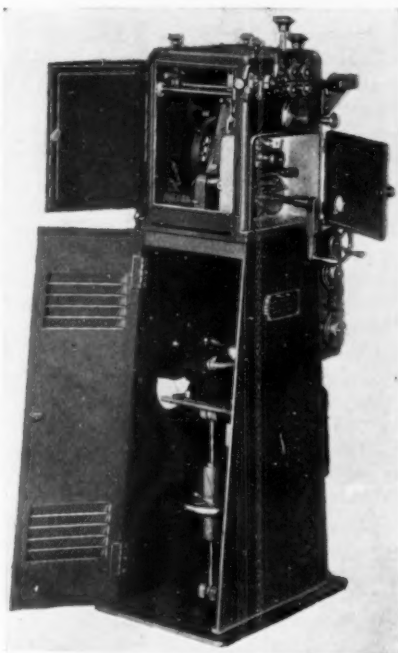
out etching, marking or loss of weight, it is stated.

Such parts may be rinsed with water to obtain chemically-clean surfaces where painting or lacquering is to follow. It is reported that where prevention of storage corrosion or rusting is desired, the parts need not be water rinsed, but are simply drained or centrifuged to remove excess solvent.

The light phenolic-type film remaining will act as a rust preventive, making an extra treatment with oil unnecessary.

New Spring Coiler

"Two hundred springs per minute" (wire diameter .004" to .028"—No. 28) is now said to be possible with the new improved No. 0 Universal segment type spring coiling machine, 24" Model, designed and manufactured by Sleeper & Hartley, Inc., Worcester, Mass.



New type spring coiling machine.

This machine, with standard equipment, will coil and cut all kinds of compression and extension springs from all size wire from .004" up to .028" diameter. Inside diameter of springs 1/32" to 11/32".

The wire feed may be increased from 24" up to 36" on sizes up to .02" through adaptation of special auxiliary gearing usable only with variable speed transmission drive.

This model is a greatly improved and more rugged design with many new and exclusive features which include one-piece cast iron housing for rigid and perfect alignment; ball-bearing construction throughout on all rotating shafts; rapid and micrometer adjustment of compound blocks facilitates set-up time; pitch and diameter cam controls readily accessible. Heretofore such control has been adjustable by reaching inside. This new coiler has a recessed cabinet on the front side, covered by hinged

Do You Want To?

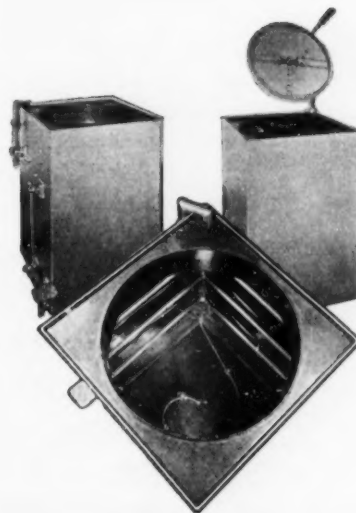
1. Lower your water costs 38 to 86%?
2. Shorten rinsing time up to 65%?
3. Rinse your work more effectively?
4. Minimize spotting and staining?
5. Eliminate "carry-over" contamination?
6. Cut your alkali and acid costs?
7. Reduce number of rinse tanks?
8. Decrease Sewage Pipe Loads?

ALL WITH ONE EASY MOVE?

OTHERS ARE FINDING IT
EASY TO DO SO WITH
"VORTEXEDDY"
SPRAY RINSE TANKS

Our Free, No Obligation, Booklet,
**"RINSING WITH SPRAY
THE STORTS WAY"**
Gives You All The Particulars

Be Sure to Mention
"METAL INDUSTRY"
When You Write for It



STORTS WELDING COMPANY

42 STONE STREET

MERIDEN, CONNECTICUT

Manufacturers of Welded Fabrications to Specification

door, and it is from this accessible point that such cam controls are adjusted.

As a result of this cabinet-feature, in case of a change or special spring, both pitch and diameter cams may be shaped, timed and affixed to the cam hub which, as an entire single unit, may be removed from the shaft without losing the timed relations. One-piece solid cams can be used on this removable cam hub.

This model may be had with choice of three types of drive, viz.—motor and variable speed transmission drive; variable speed motor pulley drive; pulley drive (flanged pulley and clutch). Weight of machine 575 lb. (motor and V.S.T. drive). Motor recommended, 1/2 H.P. 1800 R.P.M. Frame 63.

Cleaning Unit for Strip Steel

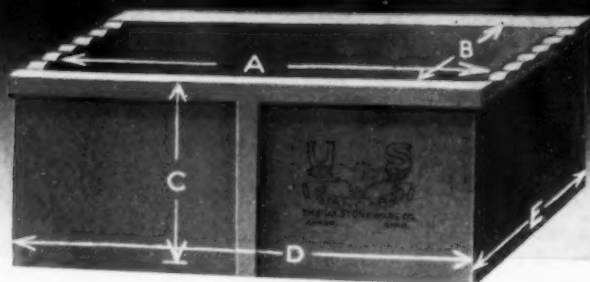
The Electrochemical Processes Division of Blaw-Knox Co., Pittsburgh, Pa., has

announced the development of a continuous unit for cleaning strip steel before annealing. The cleaning principle is said to be new and electro-mechanical in nature, providing for a faster and sharper cleaning action with an appreciably lower consumption of current. These advantages reflect themselves in lower cleaning costs.

An outstanding feature of the design is the short length of cleaning line, being only 95' from center to center of payout and windup reels. Despite this economy in space, the unit is designed, the manufacturer states, to clean 1500 ft. of strip per minute. A cold mill type of electrical strip tension control for the full length of the line has the objective of eliminating loss or delays due to folded or damaged strip. There is fully automatic control of the solution and temperature, it is said.

It is also reported by the company that electrocleaners now in service can be converted to this new type.

ACID-PROOF TANKS



Made of "DENSTONE"—an Acid-Proof Chemical Stoneware, dense-bodied and non-porous, and made from De-Aired (Vacuumized) clays.

All tanks are unqualifiedly recommended for electroplating, galvanizing and pickling work. The dense, granite-like body is acid and corrosion-proof all the way through.

Write for information about our
CORROSION-RESISTING TANK LININGS for:

- Pickling Tanks for stainless-steel
- Plating Tanks for bright nickel, copper, etc.
- Chromium Plating Tanks
- Pickling, Cleaning and Plating Tanks for all purposes

THE U. S. STONWARE CO.
WORKS (SINCE 1865) AKRON OHIO

Gal.	Length in Inches	Width in Inches	Depth in Inches	List Price
4	12	9	9	\$14.00
10	16	12	12	23.00
16	20	16	12	32.40
26	24	16	16	42.00
38	28	20	16	65.00
41	24	20	20	66.00
44	32	20	16	78.00
66	32	24	20	96.00
69	40	20	20	104.00
104	36	28	24	140.00
119	48	24	24	152.00
149	60	24	24	206.00
210	48	32	32	248.00
320	72	32	32	360.00

Special sizes made to order. List prices subject to discount.

New Welders' Gloves

The Industrial Gloves Co., 754 Garfield Blvd., Danville, Illinois, has recently added a one-piece back welders' glove to its line of industrial safety clothing. The new glove, designated as Safeguard No. 13475, embodies several features designed to give the wearer greatest possible efficiency and long service.

The entire back of the glove is made from one solid piece of leather, thus eliminating burning out of seams, one of the most troublesome features of ordinary welders' gloves. An extra wide leather strap protects and reinforces the thumb seam, and all other seams at points of greatest wear are welted for extra reinforcement. A wool heat-breaker is securely sewed to the back of the glove, inside, to provide insulation against heat.

The entire glove is manufactured from



One-piece back welders' gloves.

shrink-proof heat-resistant leather of special tannage, developed exclusively for this manufacturer. It remains soft and flexible under the most severe temperature conditions.

Another claimed economy feature of the glove is that it can be supplied in all lefts or all rights, or in any combination of lefts and rights, at no increase in cost over regular pairs. The manufacturer will be glad to furnish complete information and prices upon request.

Manufacturers' Literature

Abrasive. Data Sheet No. 1 presents detailed description of "Borolon," aluminum oxide abrasive grain for the polishing trade and general industrial uses. Abrasive Co., Philadelphia, Pa.

Blowers. Bulletin No. 120-B11, illustrating and describing single and multi-stage centrifugal blowers and exhausters. Pressure-volume curves and information regarding operating characteristics of this equipment are given. Roots-Connersville Blower Corp., Connersville, Ind.

Burnishing Materials. These materials are illustrated and described in a folder issued by H. Leroy Beaver, Lansdale, Pa. The formed pieces are designated as Pebs, Balcones, Finbals, Ovalbals, Diagonals and Diamonstels.

Chart. Jessop Steel Co., 545 Green St., Washington, Pa., has issued a new wall chart which gives the specifications for its rolled composite die sections, used in dies for cutting sheet metal to regular or irregular shapes. The chart is printed on heavy varnished cardboard stock.

Cleaners. This folder gives details concerning "Permag" cleaning compounds for the aircraft and automotive transportation industry. Magnuson Products Corp., 3rd and Hoyt Sts., Brooklyn, N. Y.

Coatings. A folder on "Spec" products, namely: "Spekwite," a tarnish-resistant electroplate; "SpekYello," a yellow bronze, said to resemble gold; "Spekaluminite," an aluminum coating for cast and fabricated products; "Kwikflux," a hard solder flux; "Dipwite," a decorative finish; "Spekleen," a cleaner; "Smutbath" for producing antique or oxidized effects, and "SpecOrak" insulated plating racks. Specials Chemicals Corp., 30 Irving Pl., N. Y. City.

Cleaners. "Clepo Cleaning Compounds" is the title of a 32-page booklet issued by the Frederick Gumm Chemical Company, Kearny, N. J. Copies will be sent on request.

Dust Engineering. Bulletin No. 250 explains electrical precipitation and its practical application to modern air filtration for ventilation, air-conditioning, and industrial processes, telling how this method removes very fine particles of smoke, fumes and dust from air or gases. By pictures and charts this bulletin describes the operation of electrical precipitation as applied

to the "AAF Electro-Matic" air filter. Engineering and mechanical data, together with 504 standard capacities and dimensions, are included. American Air Filter Co., Inc., Louisville, Ky.

Dust Filter. Bulletin 24-C. This dust filter (tubular bag type), is reported to be useful for foundry dust, cement, coal and stone dust, glass and clay dust, rubber manufacturing plants, chemical laboratories and factories, and food products manufacturing. Ruemelin Mfg. Co., 3860 N. Palmer St., Milwaukee, Wisc.

Electric Hammer. A handbook of portable electric hammers has been released to the trade by the Van Dorn Electric Tool Co., Towson, Md., giving complete details of operation, typical uses, a list of available hammer tools and their uses, and special pointers on maintenance and operation of the tool itself.

Electroplating Finish. A new electroplating finish called "Moly-Black" for the production of deep-black, high-luster deposits, is described in a folder issued by E. I. du Pont de Nemours & Co., Inc., Electroplating Div., Wilmington, Dela.

Face Shields. This subject is covered in a catalog, featuring seven models and fifteen different numbers. It describes in detail the right face shield for the job. Some models may be adjusted, due to complete interchangeability of parts, to almost every industrial need, it is stated. The Boyer-Campbell Co., Book Bldg., Detroit, Mich.

Foundry Equipment. This catalog features the ten new models of Royer sand conditioners, combination scrap remover-conditioners, and shake-outs in both portable and stationary units, including the new "Royer Jr." Royer Foundry & Machine Co., Kingston, Pa.

Fume Collector. Bulletins No. 24-C and 37-C illustrating the line of welding fume collectors and cloth type dust filters manufactured by Ruemelin Manufacturing Co., 3860 N. Palmer St., Milwaukee, Wisc.

Liquid Conditioner. Some of the outstanding features of the "Gale" liquid container claimed are: it works by gravity; can operate under unstable conditions, such as on shipboard; no moving parts to wear; no labor needed in operation. Gale Products Co., 50 West St., New York City.

Optical Pyrometer—Potentiometer Type. Calibrated, directly in temperature degrees, it is said to measure temperature more conveniently and with greater accuracy. Catalog N-33D, issued by Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

Plating Equipment. A new catalog published by Chas. F. L'Hommedieu & Sons Co., 4521 Ogden Ave., Chicago, Ill., describing equipment sold by L'Hommedieu in the plating and polishing fields. The book also contains recommendations for finishing, data on platers' chemicals, conversion tables, charts and other data of value to the electroplater. A well printed and edited catalog and handy reference volume.

FINAL SCORE

RITE - SPEED 32 - BLANK O



Kicked off in '24

Leading by '29

"ALL AMERICAN" '39

**HAMMOND Type "RO" Overhanging
Spindle Rite-Speed Polishing Lathe**

**"One of the STARS in a
Strong Line"**

"Complete that Pass" — by sending rough and finished samples of those Production Jobs for estimating purposes.

We build a wide line of both ROTARY and STRAIT LINE AUTOMATICS and may be able to help you reduce your finishing costs.

Samples should be addressed to us at Kalamazoo for attention of Engineering Dept.



HAMMOND "J" AUTOMATIC
"Always kicks the extra point" on production jobs.

Hammond Machinery Builders

KALAMAZOO, MICHIGAN, U. S. A.

1601 DOUGLAS AVE.
Eastern Office—71 W. 23rd St., New York City

Polishing Cement. A folder describing the use and application of "NuGlu", a liquid cold glue for setting up polishing wheels, belts and discs. J. J. Siefen Co., 5657 Lauderdale St., Detroit, Mich.

Pyrometer. "Wheelco" surface temperature pyrometer, series 2850, for precise readings of all surface temperatures, is covered in Bulletin 2850-1. Four models of thermocouples are offered for surface temperature work—the lava, bow, general purpose and needle types. Wheelco Instruments Co., 1929 S. Halsted St., Chicago, Ill.

Sander. The new dustless "Take-About" sander Type BB-10 is featured in form No. 584-KM-MAT-KP. This sander is said to excel in usable horsepower, silent chain drive, balance, quick-flip lever belt change, high front motor cooling air intake, and a

vacuum dust pick-up system. The Porter-Cable Machine Co., Syracuse, N. Y.

Tubing. "Agalloyed"—a steel tubing said to be comparable in quality and appearance to cold drawn seamless tubing and competitive in initial cost with joined steam tubing, has been announced by AGA Metal Tube Co., 1029 Newark Ave., Elizabeth, N. J. The tubing is reported as being used in golf shafts, fishing rods, radio antennas, lighting fixtures, etc.

Welding. 101 welding ideas for low-cost maintenance are discussed in a catalog issued by the Lincoln Electric Company, Cleveland, Ohio.

Wire Rope Clamp. Data are given in a folder on the "Safe-Line" wire rope clamp, which claims to prevent personal injury and eliminate splicing and serving. National Production Co., 4561 St. Jean Ave., Detroit, Mich.

NEW! BETTER!

PLATING RACK COATING

**Lasts Longer
Cuts Costs**



THE RESULT of extensive research by United Chromium, Inc., Unichrome Rack Coating-W provides a combination of important advantages found in no other rack coating material. Already in active use in many plating shops, it has produced amazingly fine results.

MANY ADVANTAGES

1. Not affected by boiling cleaners or plating solutions.
2. Does not blister or crack.
3. Tough—withstands wear and tear of normal handling.
4. Contains no ingredient harmful to any plating solution.
5. Cuts costs—by greatly reducing frequency of recoatings.
6. Easy to apply—by "dip and force-dry" method.
7. White in color—easy to see how completely the rack is covered.
8. Any part of rack can be recoated without necessity of recoating entire rack.

PROVED ECONOMY: Companies who have thoroughly tested Unichrome Rack Coating-W are without exception enthu-

siastic about it. Reports show that some racks coated with this material have gone through over 1,000 plating cycles without any insulation breakdown.

*Write for Bulletin No. 27
containing complete information*

Platers without rack dipping and drying facilities may have their racks coated with Unichrome Rack Coating-W by making arrangements with Chromium Corporation of America, 4645 West Chicago Avenue, Chicago, Illinois, or Lea Manufacturing Company, Waterbury, Conn.

UNITED CHROMIUM INCORPORATED

51 East 42nd Street, New York, N.Y.
2751 E. Jefferson Ave., Detroit, Mich.
Waterbury, Conn.

*Trade Mark
Reg. U.S. Pat. Off.



Letters From Our Readers

Water for Plating

Dr. Walter R. Meyer, Editor
METAL INDUSTRY
New York, N. Y.

Dear Sir:

All observations have indicated that there is a problem in the plating industry which has received very little public consideration. That is the problem of water supply.

I do not know how much study has been given this subject, but there is certainly very little available in current journals.

I have in mind particularly the problem of supplying water of adequate purity to plating solutions which are operated at elevated temperatures.

The evaporation of water from many such plating solutions is appreciable and these plating tanks serve as a concentrating tank for the impurities in the water.

For the past few years, the quality of plating chemicals has increased and, in many cases under observation, we have found that the impurities introduced into the plating bath from a water supply are much greater than that introduced through impurities in the chemicals used for maintenance of the solution. Hence, it appears that our efforts in producing purer and purer chemicals for electroplating have been futile insofar as the maintenance of a high purity plating solution is concerned.

In some localities, the water used for replenishment is extremely hard and soon forms a voluminous precipitate in the bottom of the plating tank.

In some cases where hard water has been encountered it was found impossible to use a bright dip after cadmium plating unless the hot water rinse thereafter was omitted. Apparently, the salt in the hot water being almost at the saturation point would cause a very beautiful but undesirable iridescence on the surface of the cadmium.

Condensed water from boiler systems in larger plants sometimes can be used for the plating department, but for many smaller shops this is impractical and undesirable.

Many of the newer plating solutions used particularly for bright deposits, require a high degree of purity and the problem of concentration of the impurities present in the water supply is one, which to our knowledge, has never been satisfactorily solved.

This might be a good subject for a thesis or for discussion in METAL INDUSTRY; we would like to have your ideas and those of your readers on this subject.

Very truly yours,

CLAYTON M. HOFF,
Electroplating Division.

This interesting and informative letter is one of many which we have received on the difficulties of using hard water. Mr. G. B. Hogaboom has also discussed, in an

Obituaries

Mrs. Frank Rushton

Mrs. Frank Rushton, wife of Frank Rushton, Pacific Coast representative of the Lasalle Company, St. Louis, Mo., died at her Los Angeles home Sept. 30th, after an illness of three weeks. She was 60 years old, and is survived by her husband, two daughters and a son.

Adolph Tischler

Adolph Tischler, founder and former president Manhattan Metallic Casket Co., New York, died July 25th in that city following an operation. Mr. Tischler was 77 years of age.

Lee Stander

Lee Stander, president of the Hauser-Stander Tank Co., Cincinnati, Ohio, died on July 31st, aged 61 years.

George Barrett

George Barrett, president of the Garvey Plating Co., Garvey, Calif., died September 1st, aged 60. Mr. Barrett leaves a wife and one son.

Edward Werner

Edward Werner, 65, who operated an electroplating business until his retirement about six years ago, died recently. Mr. Werner was born in Vienna, Austria, and came to this country at an early age, living in Milwaukee forty-five years. He is survived by a brother, Adolph, in Milwaukee, and by many nieces and nephews.

article in the April 1939 issue of METAL INDUSTRY, the difficulties arising from the use of contaminated water. This is a serious problem especially in view of the newer high speed and bright plating solutions which have been developed, and which are particularly sensitive to organic and inorganic impurities.

Comments or suggestions on this subject by the readers of METAL INDUSTRY will be welcome.—Ed.

Associations and Societies

American Electroplaters' Society

Boston Branch

Boston held a meeting on October 5th at the Bradford Hotel, Boston.

The Banquet Committee made its final report, and they tried to secure better rates for the meeting. The Manger Hotel could give the better rates, and starting with the November meeting, meetings will be held at the Manger Hotel.

W. J. R. Kennedy, executive secretary, was on hand and presented a question in the Question Box for the discussion of the members.

A. W. Garrett, Secretary.

Dayton Branch

The committee for the annual meeting of the Society, to be held at Dayton in June 1940, is working hard on plans for the convention. The following committee has been appointed:

Chas. C. Conley, General Chairman; Corliss W. Powell, Secretary; William Durnbaugh, Treasurer; William J. Wise, Publicity; H. C. Luechauer, Educational; G. Lewis Smith, Exhibits; Corliss W. Powell, Program; E. W. Cochran, Banquet and Entertainment; Leon L. Haas, Registration; Edison C. Sickman, Recreation; Fred Berner, Plant Visitation; Robert B. Skinner, Hotel Reservations; Clarence Folz, Transportation, and Walter Fraine, Advisory.

Detroit Branch

Plans have been completed to make the annual meeting on December 9th the biggest and best in history.

The following speakers have been secured for the educational session: Dr. Colin G. Fink, Columbia University, N. Y.—"The Electrodeposition of Manganese"; Dr. A. Kenneth Graham, consultant, Jenkintown, Pa.—"A Discussion of Electrolyte Films"; T. F. Slattery, Bureau of Printing and Engraving, Washington, D. C.—"Electrolytic Processes As Applied to the Production of U. S. Currency, Bonds and Stamps."

On November 3rd, the Branch will hear an address entitled "The Overlooked Problems of Electroplating" by G. B. Hoga-boom, Hanson-Van Winkle-Munning Co., Matawan, N. J.

Frank C. Mesle, Oneida Ltd., Oneida, N. Y., was the speaker at the October 6th

CHROMIC ACID

Recognized as the world's largest manufacturer of chromium chemicals, Mutual brings to the plating industry a basic source of chromic acid.

Our facilities cover every step in its production, from the mining of the chrome ore on a remote island in the Pacific to the wide distribution of the finished product through warehouse stocks in the principal consuming centers.



CHROMIC ACID
OXALIC ACID
BICHROMATE OF SODA
BICHROMATE OF POTASH

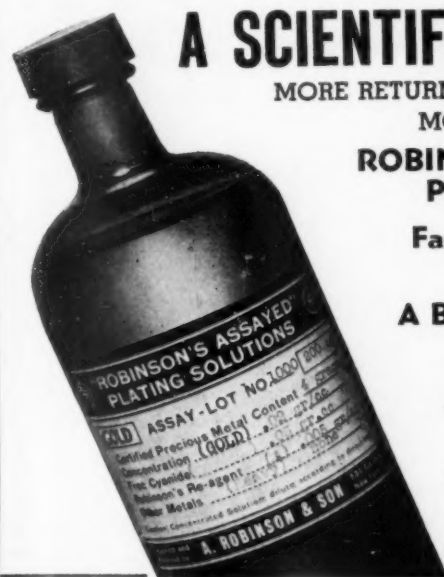
Mines in New Caledonia

Plants at Baltimore and Jersey City

Warehouse stocks carried in all principal cities.

MUTUAL CHEMICAL CO. OF AMERICA

270 Madison Avenue, New York City



A SCIENTIFIC ACHIEVEMENT

MORE RETURN FOR YOUR DOLLAR.

MORE HEALTH FOR YOUR PLATER

ROBINSON'S ASSAYED GOLD PLATING SOLUTION

Fast—Exact—Modern—Clean—Economical

A Boon Both to Large and Small Consumers.

A. ROBINSON & SON

"Sixty years at Precious Metals"

131 CANAL ST.

NEW YORK

Consulting and Analysis Service to Users Without Charge

STAINLESS STEEL POLISHING COMPOUNDS

Are Proven Every Day in Every
Kind of a Metal Working Plant



"4-A" Polishing Compounds Are Faster, More Efficient, More Economical
for Polishing, Mirror Finishing of All Kinds of Steel, Including Stainless
Steel and Other Alloys.

CEMENT AND THINNER

Use it on any kind of a wheel, soft, hard, medium. Results will speak
more eloquently than anything we could say.

Tell us about your toughest job, and we'll be glad to send the "4-A"
product that will solve your problem. No obligation, of course.

*Instead of glue, use "4-A" Cement and Thinner, a uniform substitute
for polishing Wheels, Belts, Buffs, Rolls, etc. Samples of
Compound or Cement sent on request.*

HARRISON & COMPANY
HAVERHILL, MASS.

meeting, and he gave an interesting talk entitled, "Plating and Testing Adherent Deposits."

Wright W. Wilson, secretary.

Newark Branch

The Newark Branch has published its program for the year in an attractive booklet, which also gives methods of analysis for plating solutions, conversion factors and other valuable information for the plater.

On October 20th, J. Mann, N. Ransohoff, Inc., Cincinnati, Ohio, spoke to the Branch on "Ball Burnishing."

The November speakers will be Dr. C. B. F. Young, Institute of Electrochemistry and Metallurgy, N. Y.—"The Proper Design of Racks and Shields for Electroplating," Nov. 3; W. A. Helbig, Darco Corp., New York—"The Use of Activated Carbon," Nov. 17.

On December 1st, Clarence W. Smith, Philco Radio and Television Corp., Phila-

delphia, Pa., will tell about the "Recent Developments in Bright Zinc Plating."

On November 14, the Newark Branch held a Social with 200 members and guests present. Horace H. Smith presided, and some of the guests were Ray Goodsell, national president; W. J. R. Kennedy, executive secretary; F. J. MacStoker and R. Liguori, New York Branch, and F. Fulforth, 1st vice-president, Philadelphia Branch.

Two memorable introductions were made, one being that of Philip Sievering, Sr., who has been in business 50 years, and the other, Mr. and Mrs. Wm. Hodecker, who were celebrating their 36th wedding anniversary.

The Branch voted to donate \$500 to the Supreme Society.

John Kotches, secretary, discharged all members of the Convention Committees with a vote of thanks.

New York Branch

The New York Branch resumed its Fall meetings on Friday, October 13th, which was featured by a talk by Austin B. Wilson, Past President of the A.E.S., and of the Chevrolet Motors Corporation, Detroit.

Past President Wilson gave a talk, beautifully illustrated with motion pictures, some in color, on plating procedures used at Chevrolet, methods of testing materials and the pictorial state of the manufacture of nickel anodes.

The meeting was well attended not only by the Branch members, but by many members who were in attendance at the Research Committee meeting, held during the day.

Dr. C. B. F. Young was technical chairman; F. J. MacStoker, secretary.

Philadelphia Branch

Philadelphia Branch plans have been completed for the annual Educational Session and Banquet, to be held November 18th.

Details regarding the meeting follow:

Dr. A. Kenneth Graham, A. Kenneth Graham & Associates, Jenkintown, Pa., will be chairman. Papers to be read are: "Rapid Plating of Heavy Nickel Deposits" by Dr. Louis Weisberg, Louis Weisberg, Inc., New York; "Modern Tin Plating Practice from the Sodium Stannate Bath" by Floyd Oplinger, Electroplating Div., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.; "Specifications for Electroplating Non-Ferrous Metals" by Dr. Wm. Blum, chemist, U. S. Bureau of Standards, Washington, D. C.; "Some of the Overlooked Problems of Electroplating" by G. B. Hogeboom, plating eng., Hanson-Van Winkle-Munning Co., Matawan, N. J.

Los Angeles

The monthly meeting of the Los Angeles Branch, American Electroplaters' Society, was held at Hotel Rosslyn, Los Angeles, on the evening of October 11, with 21 members present.

President Ray Bray presided. Highlight of the session was the reading by D. N. Eldred of El Monte, Calif., of a paper on "Black Plating of Molybdenum," as prepared by R. O. Howell and R. A. Hoffman, of Cleveland, Ohio, developers of the process last year. With the paper, Eldred presented tables on temperature, voltage, plating time and current density. Considerable attention was drawn to the local samples displayed by Eldred as the results of experiments he had conducted with the process in his own shop. The samples showed the deposit on steel, bright zinc and on a polished aluminum die casting. M. D. Rynkofs, past president of the Los Angeles Branch, expressed the thought of the group when he stated "this process is the most important one submitted to this branch since the invention of chromium plating."

M. D. Rynkofs, head of the chapter committee, announced that by November 1 an elementary laboratory will be ready at the school for teaching the preparation of standard solutions. Next year it is hoped to set up a miniature plating shop as an adjunct to class work.

NOVEMBER, 1939

ORGANIC FINISHING

SECTION OF METAL INDUSTRY



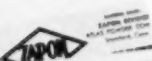
ACQUERING • ENAMELING • JAPANNING • PAINTING

duranite Today's Finish For Today's Products



DURANITE is the name adopted for ZAPON's new finish. It is a new heat reactive finish available in pure white and a wide range of colors for spray or dip application. Upon heating it undergoes chemical change which converts it to a finish resistant to water, acids, alkalis and solvents. It is a finish that is a permanent finish.

Duranite is changed by heat into a hard, baked finish. It is a finish that is a permanent finish. It is a finish that is a permanent finish.



For Today's Metal Products
Today's Finish...duranite

THIS COMPACT, FOR INST.

This compact formerly needed a primer, white and buffing after top coat. Today Duranite does the entire job in one coat. It is a finish that is a permanent finish. It is a finish that is a permanent finish.

For its use, at 120° F. immersion for 15 to 30 minutes. It is a finish that is a permanent finish. It is a finish that is a permanent finish.



DURANITE, the new ZAPON heat reactive metal finish, makes a new high in finishes combining high production speed, lower finishing costs and higher quality of final finish.

DURANITE may be applied to metal surfaces by spraying or dipping. The finish is a permanent finish. It is a finish that is a permanent finish.

duranite A TALE WELL TOLD

In March 1938 we announced that "DURANITE" had been adopted as the name for ZAPON'S new heat reactive finish. In that and subsequent advertisements we told of Duranite's complete change under heat to a finish that's resistant to water, solvents, alkalis and acids; of its speed in production.

We told also how tough, adherent and long-wearing Duranite is and of its range of colors, including pure whites and clear Duranite. We pointed out Duranite's many applications, including refrigerators, washing machines, furniture, and a host of metal products.

The continuous story of Duranite has helped sell countless manufacturers on the wisdom of employing this versatile finish. And everything we've said about Duranite has stood up to the test of time.

DURANITE—Trade Mark.



REFRIGERATOR finishes were formerly applied in two coats, each approximately 1/32 inch.

The ZAPON'S new heat reactive finish, applied in one coat, gives approximately 1/32 inch of finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

*duranite Today's Finish For Today's Products CAN I AFFORD DURANITE?

The chances are you can afford DURANITE. ZAPON'S highly successful new heat reactive finish is a single form of finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

It is a finish that is a permanent finish. It is a finish that is a permanent finish.

duranite Today's Finish For Today's Products

FACTS VS. ORDINARY FINISHES

For inclusion in water for better adhesion and superior finish quality and economy of finish is important. Chemical and mechanical resistance to water is a must. Duranite is a finish that is a permanent finish. It is a finish that is a permanent finish.

Property	Duranite	Ordinary Finish
Adhesion	Excellent	Poor
Chemical Resistance	Excellent	Poor
Mechanical Resistance	Excellent	Poor
Water Resistance	Excellent	Poor
Heat Resistance	Excellent	Poor
Corrosion Resistance	Excellent	Poor
Appearance	Excellent	Poor
Cost	Low	High

The above is not an exhaustive list of properties. It is a finish that is a permanent finish. It is a finish that is a permanent finish.



duranite breaks down... after 600 hours!

0-100 method of testing Duranite finish. It is a finish that is a permanent finish. It is a finish that is a permanent finish.



• TWICE SOLID CONTENT • SPRAY, DIP OR ROLLER COAT • WATER WHITE



EASTERN SALES:
ZAPON DIVISION
ATLAS POWDER COMPANY
Stamford, Conn.

WESTERN SALES:
ZAPON-BREVOLITE DIVISION
ATLAS POWDER COMPANY
North Chicago, Ill.

INDUSTRIAL FINISHES



REG. U. S. PAT. OFF.

Section of
METAL INDUSTRY

Founded January, 1903

Publication Office
116 John Street, New York

ORGANIC FINISHING

SECTION OF METAL INDUSTRY

NOVEMBER, 1939

CONTENTS

ARTICLES

Increasing Conveyor Oven
Capacity—By Willough-
by G. Sheane 540

Useful Pointers for the Ja-
panning Department—By
Frank V. Faulhaber ... 541

Surface Treatment of Mag-
nesium Alloys—By Leo
Grant 544

Adherence of Organic
Coatings to Metals—By
Dr. A. E. Schuh 546

Modern Developments in
Blast Cleaning Methods
—Part II—By Carleton
Cleveland 548

DEPARTMENTS

Shop Problems 549

Organic Finishing Digest.. 550

New Equipment and Sup-
plies 552

Manufacturers' Literature . 554

Accelerated Testing of Organic Coatings

There was a time, and that not so long ago, when the accepted procedure for testing finishes was a field trial under real operating conditions. Sufficient time was allowed for a thorough practical test and decisions were made strictly on the basis of actual performance. Today, however, with the ever increasing necessity for speed in manufacturing to satisfy rapidly changing style and design demands, this is impossible. To expedite production it has become essential that accurate appraisals of finishes be made without time-consuming field trials. The means to this end is accelerated testing—experimental treatment which intensifies conditions causing breakdown and allows quick evaluations to be made.

How reliable is an accelerated test? Can the results obtained be considered sufficiently indicative of what may happen to risk the possibility of early deterioration and complaint? In spite of the statement that no system of laboratory tests can compare with actual behavior in the field, it is entirely possible to make excellent predictions. This has been accomplished more times than can be attributed to chance and so it can be safely said that, properly applied, accelerated testing is entirely dependable.

However, to successfully devise, perform and interpret accelerated laboratory tests there are certain requisites which must be fulfilled. First, it is most important that a complete knowledge be had of the conditions to be met in the field—the factors involved, the intensity of those factors and the order of their occurrence. An absolute understanding and appreciation of the physical and chemical reasons for finish failure is also necessary. Finally, and particularly in the interpretation of results, it is helpful if there is a log of proven correlations between the laboratory and the field, that is, the experience of many critical and successful analyses.

Increasing Conveyor Oven Capacity

By Willoughby G. Sheane

Chemical Engineer,
General Electric Co.,
Bridgeport, Conn.

The author discusses an inexpensive addition to bar type conveyor ovens for increasing the capacity. The plan has been successfully used in the past and finds new application where the recently developed short bake organic finishing materials are used.—Ed.

The advent of short-bake organic finishing materials has been of great benefit to the finishing industry, particularly in those cases where increased production is desired without investment in new or additional baking equipment. Many manufacturers have successfully taken advantage of these new materials, obtaining greater oven output with no change other than a temperature compensation. In fact, as production demands increase, the baking schedules of some ovens are successively reduced until the original situation, lack of adequate baking facilities, is reached again.

In such instances the problem generally occurs at the unloading end of the oven. At reduced schedules complete clearing of the bars is difficult, if not impossible, because of the rate at which the conveyor is moving. This is particularly true if, as is usually the case, the unloaders are required to separate and stack the finished pieces. Additional labor may be used to compensate for an increased conveyor speed, but only to the point where interference between the unloaders occurs and labor efficiency begins to fall off.

A typical bar conveyor oven is illustrated in Figure I. Attention is directed to the single unloading point, where the difficulty mentioned above originates. As the conveyor speed increases, the number of bars passing the unloading point also increases and in effect the vertical working area (as limited by the reach of the unloaders) is pro-

portionally reduced. Therefore, if an oven is to operate at a higher conveyor speed, and is to be unloaded at maximum labor efficiency, sufficient vertical working area must be provided. This can be accomplished at relatively small expense as shown in Figure II.

The plan is not a new one, but it is particularly effective. By carrying the conveyor through another vertical pass, two additional unloading points are obtained. This not only increases the vertical working area amply, but allows an easier segregation of parts, if that is necessary. Interference is reduced and consequently there is less confusion. If floor space and the design of the baking zone of the oven permit, this plan may be expanded to two vertical passes at the unloading end for still greater production. However, such a procedure may require that a similar pass be built at the loading end. In either case, this plan should prove more economical than purchasing a larger oven or an additional oven to augment the one in operation.

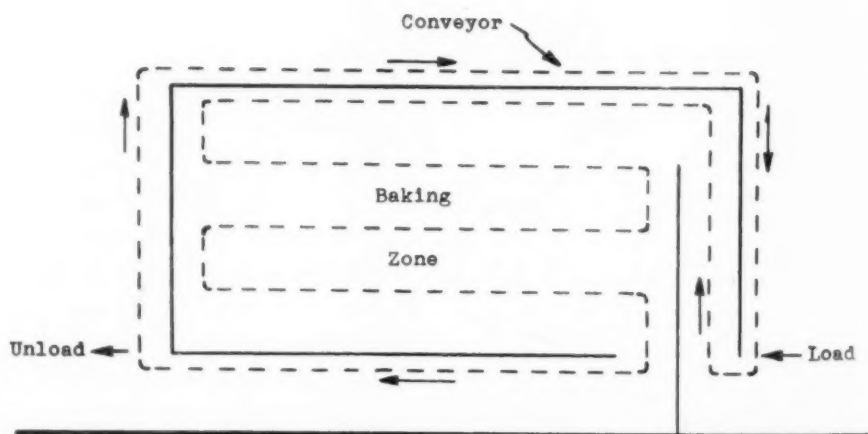


Fig. I. Bar conveyor oven, side elevation single unloading point.

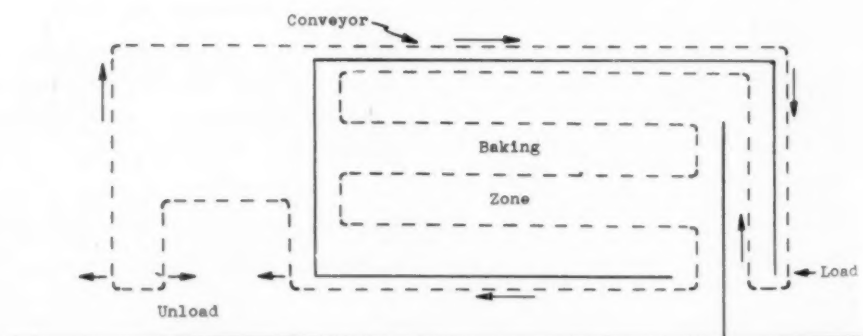
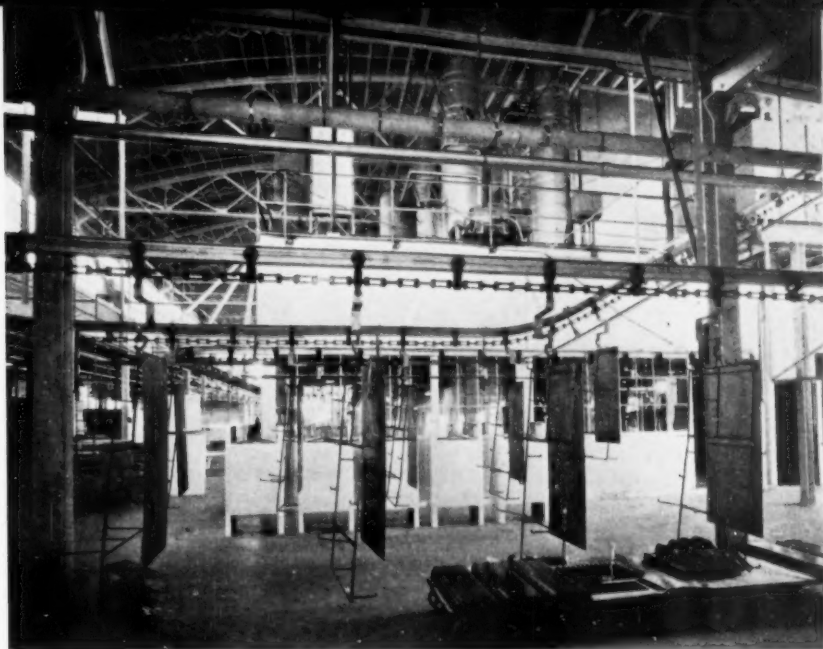


Fig. II. Bar conveyor oven, side elevation with additional unloading points

View of part of a large conveyor showing work being transported to the spraying line.



Useful Pointers

for the Japanning Department

By Frank V. Faulhaber

Pertinent, constructive ideas for the plant processing japan work:—advice on cleaning, ovens, and japanning technique are given. Various defects such as sagging, pitting, flaking are discussed.—Ed.

Introduction

Japan, an ever-popular standby among finishes, is also one of the oldest. When one thinks of a japan finish he also thinks of enamel, which many use interchangeably; however, japans are usually cheaper than enamels. Japan is hardened by baking in an oven heated by electricity, gas, steam, oil, coke, or other means, albeit among finishers the expression, air-drying japan, is frequently heard. Japan originally referred to black japans, although nowadays colored japans come within the same category.

To meet the need for a quick-drying, tough, durable varnish on metal, baking japans were developed. There has been increasing popularity in black baking japans where the objective is a high quality finish, cheaply, quickly and easily processed. The old air-drying method involves more work, requiring more time, and is generally more expensive. Black japan work makes for a strong, resistant finish, and in industry today has place in the production of numerous articles. Many articles of manufacture have been widely popularized by reason of their finishes in japan, which is highly resistant to the destructive or discoloring action of the weather, acids, heat and various other disintegrating agents.

Ovens for Japanning

As with practically all finishing work, satisfactory japanning entails absolute cleanliness. The ovens, the rooms and all apparatus in the rooms should be clean, and dust proof, for no finish will reveal specks of dust and other defects as plainly as a bright gloss finish, particularly on a smooth, flat surface. The sides and the roofs of the ovens should be cleaned, removing all rust, scale, and other particles. This work can be done with a scraper, afterwards washing with a rag or sponge, wet with reducer. Then the heat should be turned on for half an hour to dry out the ovens. The interior of an oven should never be painted or oiled, as it will eventually flake off, falling on the work. All hanging bars and hooks should be maintained clean, and the flue pipe free from dust.

The majority of ovens in use are heated by gas or electricity, and are most commonly made of sheet or galvanized iron. They are manufactured in a wide variety of types, sizes and designs. They range from the size of a small refrigerator to some which occupy practically two floors of a long industrial building. A good oven should be well insulated.

Factors that should govern the se-

lection of drying ovens for japanning work depend upon the character of products to be japanned, the amount of daily or hourly production desired, the entire finishing process including operations preceding and following baking, the size and type of the factory building wherein the equipment is to operate, and other plant influences. For small ovens, the finished units may be placed in trays or on racks or trucks. Systematic, speedy loading and unloading is essential to ensure maximum efficiency—avoiding needless wastage of heat, time and handling and also preventing any spoilage of the work in process.

In those plants where small cabinet-size ovens are used for japanning, the usual procedure is to dip or spray the small parts in process while these are in place on trays, racks or hooks and then transfer them with minimum handling and the least possible time into the oven.

For the large plants processing japan work, large conveyor ovens of various types are employed. Frequently the conveyor oven is linked up with automatic cleaning and dip finishing operations preceding the actual baking operation, while cooling and unloading stations follow the baking operation. To illustrate, in one large plant the equipment comprises three bake ovens and three dip tanks, the former being housed in a building erected on the roof of the main factory and the latter on the top floor. The arrangement is continuous and automatic in operation, three coats be-



Fig. 2. Girl operator applying enamel coating to small parts.

ing applied and baked in three ovens with the use of a single conveyor.

The individual units are set in a single straight line so that the one traveling conveyor serves them all without any change in direction in the horizontal plane. In the vertical plane, however, the conveyor travels up to the roof to the gas ovens, returns below to the dip tanks and repeats until the cycle is completed. Along the line of travel of this conveyor and directly beneath the ovens, this section of the top floor is divided into eight sealed rooms. The first and last rooms are used respectively for loading and unloading the conveyor, while the second, fourth and fifth contain the dip tanks. Clean, filtered air is blown into these rooms and just enough air pressure is maintained within them to prevent the infiltration of outside air containing dust, dirt and other foreign substances. Thus is ensured superb quality of the completed japanned coats.

Conveyors

The conveyor, consisting of two parallel chains between which rods are suspended, is operated by a motor located close to the unloading end. By controlling the speed of the conveyor, through a speed-reduction gear train, the baking periods are regulated within any time limits required. The parts are hung onto the conveyor and never leave it until it is unloaded. During its travel it receives three coats — priming, rubber and finish—each coat being baked separately in a different oven, and at approximately 450°F.

These bake-finishing ovens are equipped with temperature controls which work automatically through motor-operated valves in the gas supply lines. When the temperature rises to above a predetermined setting, the valve closes, but enough gas passes through a bypass to keep the pilots going. When the temperature drops, the valve opens. *All pilots are supplied with sparkplugs operating intermittently.*

By means of the variable speed drive of the conveyor, and the tachometer recording the speed in feet per minute as well as length of time the parts spend in the oven, and the counter-mechanism indicating the number of units passing through the oven, the finishing foreman has before him precise, systematic operation, enabling him to know to a nicety just how the entire japan work is processing. No guess-work. The results are surer and more satisfactory.

The conveyor ovens offer many advantages to the large plant. There is no cluttering up of floor space with loaded trucks of work awaiting the ovens, while other work in baking process is undergoing the proper baking treatment. Handling of work from the benches to the trucks, loading and unloading ovens and trucks, requiring considerable labor and waste motion,—all these are eliminated. No processed work piles up, nor is storing necessary of parts which cannot be absorbed in succeeding operation. Nor, again, is there any necessity for opening and closing of oven doors in loading and unloading the trucks, caus-

ing the loss of heat, drop in temperature and consequently an increase in the amount of time required for satisfactory baking.

The ovens must not be set up near wood structures of any kind in the factory; they should be safe against explosions; and the management should have eye to heating economy, which latter may govern the type of heating unit to select. Ovens heated by gas should be of the indirect type, in which the burners are enclosed in a separate heating chamber, eliminating all danger of fire and explosions.

The ovens should be of a kind permitting clean work, and the more uniform the oven temperature, the less possibility of color variation frequently encountered in japan finishing. Much of this trouble is due to improper adjustment of the heat circulating in the oven. When baking white enamels, extra care must be exercised regarding the oven temperature; the slightest variation in temperature often results in discoloration. Usually, the lighter the color, the lower the temperature at which it must be baked. The average temperature for grays, for instance varies around 175°, vermilion 175° and dark greens 250° F. Furthermore, the temperature at which black baking enamels are processed is determined by the general make-up of the baking varnish; discoloration in the black work is not noticeable.

Handling of Japans

There is frequently lack of uniformity in results obtained with black japans. Test the japan with a hydrometer and maintain it at the proper Baume reading, consistently. The japan can be prepared with the proper reducers the night before and letting the japan set all night after mixing, allows any foreign substances to settle to the bottom of the dip tank and be ready for use the following day. Of course, there are divers bearing factors to keep in mind, as the temperature, the next day, and this also affects the specific gravity.

The foresighted, careful foreman will insist on clean japans, cleanly used. Strain the coating materials into the dip tank. For this purpose, a wooden frame can be made about the

with of the dipping tank, interiorly, with the ends projecting so that the frame will rest firmly and securely on the tank. This tank should be lined with coarse wire screen (chicken wire), allowing it to sag about six inches in the middle. Two layers of fine cheese cloth should cover same, with an additional layer of tailors' wadding in between.

Ordinarily, japans are made heavy enough in body to stand reducing to a degree suitable for the work under hand. By experiment, one can determine the most satisfactory quantity of reducer to use to obtain the desired coating. By dropping the hydrometer into the mixture, the reading can be taken and future mixtures be maintained at the same specific gravity. The thinner should be stirred in thoroughly.

Most of the japans can be reduced with naphtha for ordinary work, but for special processes, where long flowing is necessary, such as on fenders and hoods of automobiles, it is always the part of wisdom to buy the reducer from the manufacturer of the japan employed in the work.

The tank should always be kept completely covered when not in use. The temperature of the room and tank should be maintained about the same — approximately 80 degrees, or as near that as possible. Should it get

cold, it can be warmed by immersing five-gallon cans filled with hot water. After removing the cans, the tank should be stirred thoroughly.

Japan operators would do well to keep records of the work under process, in a special record book, including therein all pertinent formulae, and everything significant touching on this work. Succeeding japanning operations will thereby be facilitated, without unnecessary time loss, and the work, altogether, will be more uniformly satisfactory.

Cleaning

Special care should be exercised to see that all steel parts are freed of all dust, rust, grease, dirt, and other foreign matter, though rough iron castings require less care in this regard. Grease is often used in the process of rolling or drawing steel and it may be present and yet be invisible to the naked eye. When baking japan on such metal, innumerable small pit marks, or sometimes large, uneven blotches will show on the finish, as the heat forces the grease through the coating during the baking process. There may even be so much grease present that the metal will come forth from the oven with hardly any japan coating.

Rare cases have been observed where the japan resins are compatible with

the oils present as impurities on the surface of the work, and in these cases, satisfactory deposits have been obtained without any previous cleaning of the work.

In general, cleaning may be accomplished in several ways, (1) by the use of solvents such as naphtha, (2) by hot vapor or solvent degreasing, and (3) by alkaline cleaning either simple immersion or by electrolytic cleaning. If straight solvent cleaning is used, the counter-flow system should be used, using several cleaning tanks. In this way, deposition of residual oils present in the solvents can be minimized. In alkaline cleaning, thorough rinsing should be done because if any alkali is left on the work, it may result in non-adhesion of the japan or of spotting. Rust may be removed by the use of hot sulphuric pickles maintained at 180° F. with an acid concentration range from 7 to 15% by weight. Commercial inhibitors may be added to prevent attack by the acid on the steel. Cold muriatic acid pickles may also be used and there are now satisfactory inhibitors on the market for this acid; usually a 20% solution of the commercial acid is satisfactory. For large objects which can not be immersion pickled, the excessive rust can be removed by mechanical means such as by manual or machine sanding.

There should be a thorough rinsing in cold and hot water tanks after cleaning and pickling, and then the work should be transferred to another room for storage. Cleaning should be done in rooms entirely separated from the finishing operations, for in cleaning and pickling, alkaline or acid laden fumes may be evolved with harmful results. The metal should not be permitted to lie around too long after cleaning as it may become dirty or rust before the japanning. The exposed surface should not be touched with damp or sweaty hands, and, before dipping, all dust should be wiped off, with a lint-free wiping cloth. Such a cloth may be prepared by taking a piece of cheese cloth, soaking it in an air-drying varnish, wringing it out well, and letting it dry until it is tacky to the touch.

When the metals are dipped, as in the smaller plants, the parts should be permitted to drip or set for the proper length of time, and the work is then ready for baking in the ovens.

(Concluded in December issue)

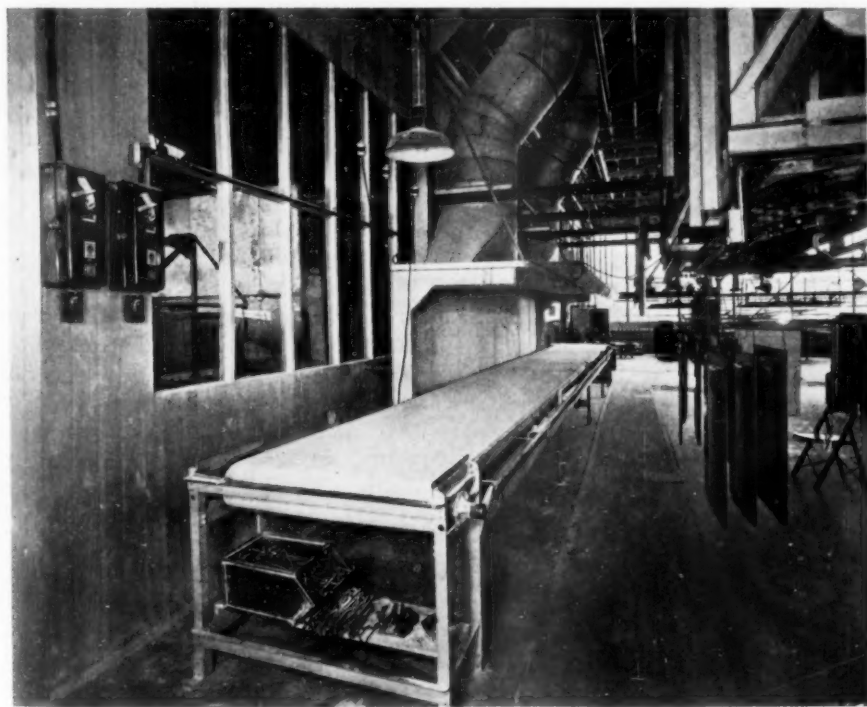


Fig. 3. Finished japanned work suspended from conveyor. Note the interesting view of bright and airy conditions.

Surface Treatment of Magnesium Alloys

By Leo Grant

Head, Dowmetal Division
The Dow Chemical Co.
Midland, Mich.

Descriptions are given of various chemical treatments for preparing magnesium alloys for organic finishing and for increased corrosion resistance to atmospheric or chemical corrosion. Advice on organic finishing materials for magnesium alloys is given. The information herewith published will appear in The Dow Chemical Co. Data Book to be shortly published.—Ed.

Magnesium alloys* with exceptional stability in all ordinary atmospheric conditions have been in successful service in many industries for the past 20 years. Test pieces have been exposed to weather in Michigan for periods as long as 10 years with no pitting, significant attack, or loss of properties. Steel, under the same conditions, is severely corroded. Polished magnesium alloys gradually darken on exposure caused by the formation of a thin dark gray film which protects against further attack.

As it is difficult to control the location and service conditions to which an article is exposed in service, a general recommendation is made that magnesium alloy parts be painted wherever possible. Chemical surface treatments have been developed that act as excellent bases for subsequent paint coats, and primers and finishes are now available that give excellent adhesion and protection. The procedures as given below exemplify the best commercial practice for both protection and decoration.

Surface Treatment

A number of chemical treatment processes are available for the decoration and protection of magnesium alloys. Some may be used alone, but for maximum protection, a combination of chemical treatment and suitable paint coatings has been most satisfactory. The need for chemical treatment depends primarily upon the

*Dowmetal

conditions to be encountered. The choice of chemical treatment depends upon the alloy composition as well as the service requirements. The coatings formed by the recommended treatments possess good bond to the metal, satisfactory mechanical anchorage for primer and finish coats, and definite corrosion inhibitive characteristics. The recommended chemical treatments described below, coat all surfaces of magnesium alloys articles equally well, penetrating even to the bottom of deep holes and pockets. Such penetration is not usually possible with electrochemical treatments which possess limited throwing power.

In applying the cleaning and treating processes described in the following pages, use is made of caustic soda, sodium dichromate, arsenous oxide, as well as nitric, sulfuric, hydrofluoric, and chromic acids. The usual protective precautions for handling these materials should be observed and the treating should be done in equipment and rooms provided with adequate ventilation.

Magnesium alloys usually are furnished with the Chrome-Pickle treatment which provides protection during shipment, storage, and machining. The Chrome-Pickle coating remaining on the unmachined areas will not interfere with the subsequent application of treatments No. 7 or 8.

Cleaning

Cleaning can well be considered the most important step in the chemical

treatment of magnesium alloys. Without adequate or proper cleaning of the metal surface, the effectiveness of the subsequent treatment can be greatly reduced.

The cleaning instructions below apply to treatments Nos. 1, 7 and 8. No deviation from these instructions is permissible if best results are to be obtained.

Before the application of any surface treatment, magnesium alloy parts must be thoroughly cleaned from all traces of grease and oil by boiling in an alkaline cleaner such as is recommended for aluminum, or preferably the stronger type used on steel. Alternatively, vapor degreasers or a wash in carbon tetrachloride, naphtha, or other suitable organic solvent can be used to remove grease and oil. If washed in organic solvent, parts must be given a final rinse in clean, unused solvent.

If before machining the magnesium alloy parts it is observed that they contain dirt not removable by organic solvent or alkaline cleaner, or if they exhibit visible surface oxidation, the parts must be treated as follows:

Dip ten seconds in a solution at room temperature containing by volume 8 parts of concentrated nitric acid, 2 parts of concentrated sulfuric acid, and 90 parts of water. Wash thoroughly in running water. Follow by a dip in hot water to facilitate drying.

NOTE: This nitric-sulfuric acid pickle MUST BE APPLIED BEFORE ANY MACHINING since the amount of metal removed is likely to exceed machined dimensional tolerances. It is quite safe, however, to pickle rough, unmachined castings and heavy sections. Surface oxidations may be removed from thin sections or thin sheet by sanding.

The nitric-sulfuric acid pickling bath may be contained in ceramic, rubber-lined, aluminum or other suitable tanks.

The magnesium alloy parts are now ready for machining operations, immediately after which they must be degreased as described above before proceeding with chemical treatment.

Treatment No. 1

This treatment, commonly known as the Chrome-Pickle, is applied to practically all fabricated forms of magnesium alloys supplied by The Dow Chemical Company and its licensed fabricators. The treatment passivates and slightly etches the metal, resulting with most alloys, in a surface well adapted to receive paint coatings. The etching action removes up to 0.0006" per surface (0.0012" per diameter) and hence can be used on machined surfaces only where tolerances will permit or where proper allowances have been made.

Treatment No. 1 also is used for weld cleaning.

This treatment is a simple dip operation requiring $\frac{1}{2}$ to 2 minutes, according to the freshness of the solution, in a bath of the following composition operated at room temperature (70° to 90°F):

Sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$)	1.5 pounds
Concentrated nitric acid (Sp. Gr. 1.42)	1.5 pints
Water	To make 1.0 gallon

Technical grades of sodium dichromate and nitric acid are satisfactory, but care should be taken that all chemicals used in the cleaning and treating of magnesium alloys are free from the salts of heavy metals. It is suggested that operators wear rubber gloves and aprons.

After the dip, the parts should be held above the tank for five seconds. This serves to allow the adhering solution to drain off, and to produce a better colored coating. The parts are now washed in cold running water followed by a dip in hot water to facilitate drying.

Treatment No. 1 produces a visible color, a luster ranging from matte to bright, and an etch which is visible only under the microscope. The color, luster, and etch vary with the age of the solution and with the composition and type of heat treatment of the alloy. Certain colors and etches are superior to others as paint bases; the

most desirable being a matte, gray to yellow-red, iridescent coating which shows a network or pebbled etch under the microscope. This type of coating is readily obtained in fresh solutions. Coatings to be avoided are those which are bright and brassy in color and which show a relatively smooth surface with only occasional rounded pits when examined under the microscope. Due to the tendency of magnesium alloy M to form bright, brassy coatings, with inferior paint adhesion, the Chrome-Pickle solution used for treating this alloy should always be kept in the fresh or renewed condition.

Depletion of the solution is indicated by the paleness of the color, shallowness of etch, and slowness of action on the metal. The paleness of color should not be confused with that obtained by insufficient exposure to air between removal from the bath and the wash in water. Nitric acid and sodium dichromate should be added until a matte or semi-matte but not bright coating is obtained on alloys of the E and F wrought, or G and H cast type. Control of the bath is best effected by analysis. Details of rapid analytical procedure are available on request.

Articles too large to be immersed should be well brushed with a generous amount of fresh solution followed by thorough washing. The coating thus formed is less uniform in color than that produced by the dip process but is equally good as a paint base.

Where the coating applied by treatment No. 1 is removed by machining or similar operation, the newly exposed surface should be cleaned free from grease and oil and then given treatment No. 1. As stated earlier, the dimensional loss will range up to 0.0006 inch per surface. If this loss is more than the dimensional tolerance it is suggested that the part be given treatment No. 7 or 8.

Magnesium alloy parts containing steel or brass inserts can be given treatment No. 1. Polished steel surfaces can be protected with a thin film of lacquer which may be removed later with a solvent.

Pure aluminum, stainless steel, glass or ceramic tanks may be used for containing the solution. Welded pure aluminum tanks are most practical for large installations.

Treatment No. 1 as described above corresponds to U. S. Army Specification 98-20010-A paragraph E-3A

and Navy Aeronautical Specification M-303a.

Treatment No. 7

This treatment provides the most salt water resistance of the chemical treatments for magnesium alloys. The treatment effects no dimensional changes and is normally applied after machining and before painting.

Castings and other parts containing bearings, studs or non-magnesium inserts of any nature may sometimes require treatment No. 7 as in the case of refinishing work. Brass, bronze, and steel are unaffected by the treatment. Aluminum and cadmium plate, however, are rapidly attacked during the hydrofluoric acid dip.

Treatment No. 7 consists essentially of two steps applied as follows after proper cleaning:

1. Immerse magnesium alloy parts for 5 minutes in a water solution containing 15 to 20% by weight of hydrofluoric acid (HF) at room temperature. A satisfactory bath can be prepared by diluting one volume of technical grade 48 to 52% HF with two volumes of water. Wash thoroughly in cold running water.

NOTE: In handling hydrofluoric acid, great care must be taken to avoid contact with the skin. Burns caused by hydrofluoric acid are extremely difficult to heal. Rubber gloves and protective clothing should be worn. Thorough and prolonged washing in water should be done immediately after accidental contact with the acid. The contacted area should then be watched carefully for several hours and a physician's advice sought at the first evidence of pain, loss of sensation, or redness of the skin. Inhalation of fumes containing hydrofluoric acid also should be avoided. A physician should be consulted in case of inhalation causing respiratory distress. Storage and treatment tanks should be provided with hoods or ducts for the removal of fumes.

While the above precautions are especially directed to the handling of strong hydrofluoric acid, they should extend to all concentrations.

2. Boil parts for at least 45 minutes in a water solution containing 10% by weight of sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$). This solution can be readily prepared by dissolving technical sodium dichromate in water in the ratio of $\frac{3}{4}$ pound per gallon. The original solution level shall be maintained by additions of water to replace that lost by evaporation. Rinse parts thoroughly in cold running water and follow by a dip in hot water to facilitate drying.

(Concluded in December issue)

Adherence of Organic Coatings to Metals*

By Dr. A. E. Schuh

*Director of Research,
United States Pipe and Foundry Co.,
Burlington, N. J.*

Organic finishes, in order to be serviceable, must adhere well for protracted periods of time to the underlying base material. It is a well-known fact that finishes vary considerably in this respect. Evidence of poor adherence, such as flaking, peeling, easy removal by some external force, etc., is so glaringly conspicuous, as to suggest a readily assignable cause for the phenomenon. Actually however, these final evidences of adherence loss are in most cases the net result of a prolonged tug-of-war among a large number of competing forces. Although the final sign of adherence loss may be the same for several different finishes, the cause and the road to failure for each may be quite different. In this paper it is hoped to point out and discuss a number of the factors that affect the adherence of different organic coatings. Some of these factors are: specific adhesion, physical state of the surface, chemical state of the surface, composition and structure of the organic coatings, and their degradation with age.

Specific Adhesion

The maximum adhesional bond which can be developed between an organic coating material and the substrate to which it is applied is determined by forces residing at the interface between the two materials. These forces determine the specific adhesion between a given surface and a specific finishing medium. The distance over which such forces can act is necessarily very short, being at most of the order of several molecular layers of constituents in the coating medium. Their sphere of action probably drops to a negligible quantity at distances of the order of a few hundred Ångström units from the substrate surface. Such a distance comprises only about one thousandth of the thickness of an average single-coat paint film. Experimental methods which permit the study of molecular surface structure are necessary for a critical examination of specific adhesion. For this study, the electron diffraction beam is proving to be useful. In the normal coating of supposedly clean, bare metals by paint media, actual metal surfaces are probably never contacted, since most metals are covered with

a thin layer of surface compounds, such as oxides, carbonates, etc. The physical and chemical character of this invisible layer sets the limit of realizable adhesion in an organic finish.



Arthur E. Schuh

Every organic coating material, whether oil-paint, varnish, lacquer, or asphaltic material, consists of a complex mixture of diverse kinds, sizes

and shapes of molecules. This heterogeneity is essential to inhibit crystallizing tendencies and to promote film-forming properties. These mixtures contain molecules or molecular groupings which are variously asymmetrical and thus have fields of force along their surfaces. Similarly, the surface of the metallic substrate is inhomogeneous and thus the source for bonding forces and attendant tendencies for alignments to satisfy these forces is provided. The substrate surface is fixed and hence, in order to make such alignment possible, a certain degree of mobility for the adhesive constituents in the organic medium must be provided. This is usually accomplished by the use of solvents, heat, or a combination of the two. However, in the case of drying oil films, the film-forming material itself at the time of application may offer sufficient mobility to permit the desired orientation for developing adhesion. In most instances, heat is definitely beneficial in promoting a high order of adhesion. The added thermal mobility offers increased opportunity for the permanently adhesive components in the coating medium to satisfy the force fields in the substrate surface.

Although specific adhesion is as yet not subject to direct measurement, a number of other factors, which from a practical standpoint are more important in determining the net adherence of an organic coating over a metal, can be investigated successfully. Such other factors are the physical and chemical character of the underlying surface, compositional factors of the finishing material, and effects of structure and aging of the coatings.

*Reprinted from Proc. of A. S. T. M., 38, p. 481, (1938).

Physical State of the Substrate

For convenience, solid substrates might be classified into those having open, sorptive surfaces and those having dense, compact surface structures. As a rule, a high order of adherence is obtained with solids having sorptive surfaces, because here, provided the surface is even moderately wettable by the painting medium, an opportunity for mechanical interlocking of the finish film with the solid substrate is provided. Fibrous materials, such as textiles, many woods, sorptive inorganic solids, and several chemical films on metals, fall into this class. Even here, however, difficulties are at times encountered, owing to local variations in substrate texture, and owing to subsequent chemical and physical changes at the interface. In general, the ultimate adherence is limited by the cohesive strength of either the finish film or the fibrous surface layer of the substrate. Following are some typical values for the tensile strength of various organic coatings, taken from the work of Nelson^{1,2,3} and his coworkers:

Linseed oil	30 lb. per sq. in.
White lead paint	240 to 500 lb. per sq. in.
Zinc oxide paint	470 to 1000 lb. per sq. in.
Varnishes	400 to 900 lb. per sq. in.
Nitrocellulose lacquers	800 to 2800 lb. per sq. in.

In the case of solids having a com-

compact surface structure, for example, metals, glasses, plastics, etc., large variations in the adherence of organic coatings are encountered. In many instances, these differences are associated with differences in surface roughness of the solid. In considering any one given metal, treated in a definite manner, the factor of specific adhesion is no longer a variable. With such a fixed chemical surface, the physical surface area may, however, vary over wide limits and the adhesion will obviously be greater in those cases where more molecular surface is offered per unit macroscopic area. Paint technology has long recognized the value of roughening of metal surfaces to promote adherence of finishes, sand blasting, shot blasting, or grit blasting, etching, and other methods having been used for many years. Information of a quantitative nature regarding the surface increase by various roughening treatments is therefore of value.

One method of approximating such measurements consists of recording at high magnifications the tracing of a fine-pointed stylus as it rides lightly over the microcontour of a roughened surface. In Fig. 1 are shown copies of such tracings over several solids blasted at 15 lb. air pressure with various particle sizes of abrasives. In general, the particle size appears to be

the controlling factor in determining the surface contour by a blasting method. As a matter of interest, the contours of roughened hard rubber and glass are also shown and in these two materials, which lie far apart in the range of their elastic limit at room temperature, the tracings are found to be appreciably different. Similar contour tracings have been presented by Darsey⁴ for steel surfaces treated in several ways.

In attempting to compute the surface area increase of a roughened metal, as compared with a polished plane surface, it must be recognized that only approximations are possible, since the radius of curvature of the tracing stylus sets the inherent limit of resolution. The point is clearly brought out in the case of polished and polished anodically oxidized aluminum. Contour tracings over these two surfaces were found to be virtually identical, the pores in the anodic oxide coating being too fine to be penetrated by the stylus. According to Rummel⁵, the cross-section of such pores is estimated to be 10^{-5} cm. and their spacing at two pores per 10^{-4} cm. With a depth of oxide coating of 10^{-3} cm., the estimated surface increase would be approximately 12.5 times the original surface area. Although the contour tracings showed no surface increase, adhesional strength measurements have shown that organic coatings can penetrate into these pores. There was found a definite increase in joint strength of the same materials when coated on oxidized aluminum. If, however, the oxide coating was sealed in boiling water, the coating constituents could no longer enter the pores and both adherence level and adherence stability were sacrificed to an appreciable extent.

From Fig. 1 it can be seen why the physical roughening of a metal surface is so beneficial for promoting adherence. Surface area increases of at least 25 fold can be estimated in a number of cases. The jagged contour produced by blasting consists of many tiny facets inclined to each other at various angles, which helps to key in the finish by neutralizing stresses normal to the surface. Methods such as blasting serve to clean the metal surfaces very effectively and this may constitute the major factor in improving the adherence of paints to blasted surfaces.

(Continued in December issue)

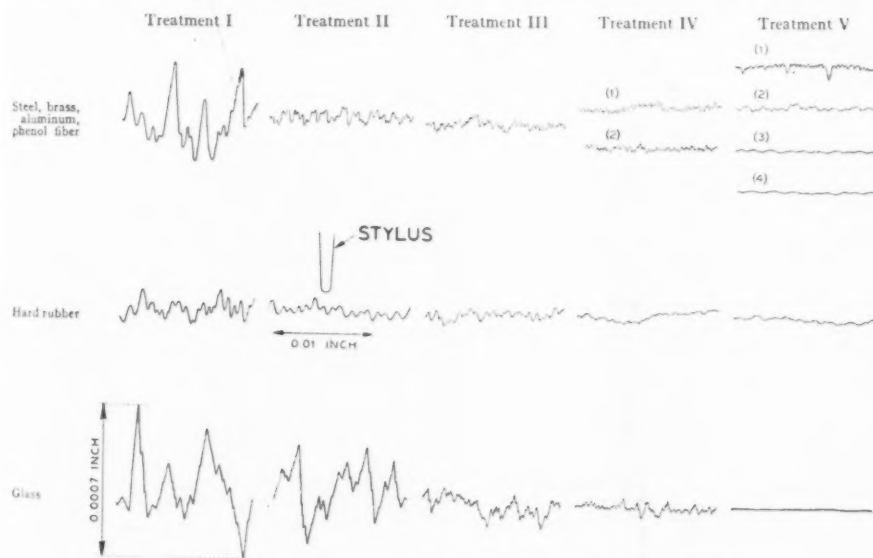


Fig. 1. Surface Contour of Various Roughened Solids.

Magnification: vertical—4700; horizontal—210. Radius of stylus 0.0005 in.
 Treatment I.—60-mesh steel grit, 30 lb. air pressure
 Treatment II.—100-mesh carborundum, 30 lb. air pressure
 Treatment III.—180-mesh carborundum, 30 lb. air pressure
 Treatment IV.—400-mesh carborundum, 30 lb. air pressure
 (1) Steel and phenol fiber
 (2) Brass and aluminum
 Treatment V.—As received
 (1) Cold-rolled steel
 (2) Brass
 (3) Aluminum
 (4) Phenol fiber

Modern Developments in Blast Cleaning Methods — Part II

By Carleton Cleveland

This concludes the story of the utilization and development of blast cleaning methods and equipment. The first part was published in the October issue.—Ed.

Centrifugal Blasting

The airless principle is adaptable to tables, cabinets, and specially designed machines for unusual types of cleaning work. Without the use of compressed air, this centrifugal force equipment cleans gray iron, steel, alloy, and malleable castings; forgings; steel products including pipes, billets, bars, strips, skelp, blooms, shapes, and various heat treated parts. It also economically prepares properly cleaned surfaces for metallizing, sherardizing, galvanizing, and other forms of plating, or enameling, painting, lacquering, or other similar finishing processes.

This type of machine utilizes the tumbling process in connection with the centrifugal force which throws a volume of the abrasive, fed from a storage hopper through a chute by gravity, at considerable speed against the work in a tumbler. In some makes of machine, this tumbler is a barrel or drum, while another maker utilizes a continuous apron conveyor, the conveyor being so constructed and adjusted that it tumbles and cascades the work directly beneath the spinning wheel which whips a continuous stream of abrasive upon the work to the full width of the cleaning chamber. The apron conveyors, made of abrasive-resisting steel, are available in various designs to suit the type of work to be done.

After blasting a load as it is tumbled over the apron conveyor, the abrasive falls through the holes in the conveyor plates into a hopper in

the lower part of the machine. Here a screw conveyor carries the abrasive to a rotary screen where all refuse is screened out. The clean abrasive then drops into the boot of a small bucket elevator and is lifted to a combination separator and overhead storage hopper from which it is fed by gravity down into the centrifugal mechanism for discharge into the cleaning zone. The abrasive cycle in the barrel or drum type unit is similar in operation, the abrasive falling through perforations in the barrel shell.

The principal of airless abrasive blasting is used in many specially

designed cabinet units for handling work where special production requirements prevail or where the work, because of its shape, or weight, is not adapted to a standard machine. These units may be of continuous action and fully automatic with the parts to be cleaned suspended from overhead trolley conveyor hooks traveling through the blasting zone, where the work is given a rolling, tipping, or spinning movement during the blasting process in order to expose all parts to the full effect of the abrasive blast.

The airless method of abrasive blasting also lends itself ideally to the rotary table type of equipment for economical blast cleaning of fragile and thin-section castings, forgings, stampings, heat-treated parts, or other pieces which might be damaged in tumbling, such as stove parts, meter boxes, battery grids, shovels, switch parts, lawn mower and farm implement parts, ring gears, bevel gears, automotive parts, etc., also parts requiring "matte" surfacing. For this



Figure 9. Charging airless rocker barrel unit using automatic loading device.

work, two types of machines have been developed—the single standard tables and the multiple spindle tables.

For all average work, the single standard table machine is used, the table consisting of a slowly revolving platform, circular in shape and of a height convenient for the operator. It carries the work placed upon it through a rubber curtain to an enclosed section where it passes under and through the abrasive blast zone and then emerges through the opposite side of the rubber curtain back to the open section. The operator then turns the work upside down and allows it to pass through the machine a second time for complete cleaning of the newly exposed surfaces.

For more complicated work, the multiple spindle tables are used.

Editor's Note: We appreciate the courtesy of the following manufacturing companies for helpful data and the pictures used in this article for illustrations—

The American Foundry Equipment Company, Mishawaka, Indiana, Ottawa Silica Company, Ottawa, Illinois,

Pangborn Corporation, Hagerstown, Maryland,

Ruemelin Manufacturing Company, Milwaukee, Wisconsin, Steelblast Abrasives Company, Cleveland, Ohio.

Shop Problems

Technical Advisor
for November Issue

Dr. Gustave Klinkenstein
Vice President and Technical Director
Maas & Waldstein Co.
Newark, N. J.

Centrifugal Lacquering

Q. Would you kindly inform me of the best way to barrel lacquer the enclosed sample. We would like to duplicate the lacquered finish as near as possible. At present we lay the work on trays and spray it, but we find it is too costly.

We would like to use gold dye lacquer on it, but if clear lacquer would produce a cleaner looking finish, then we would consider changing the color of the brass solution a little.

A. From the nature and shape of your articles, I don't think that they are best adapted for barrel lacquering. It seems to me that the most economical way to lacquer and color these buckles would be in a centrifugal machine.

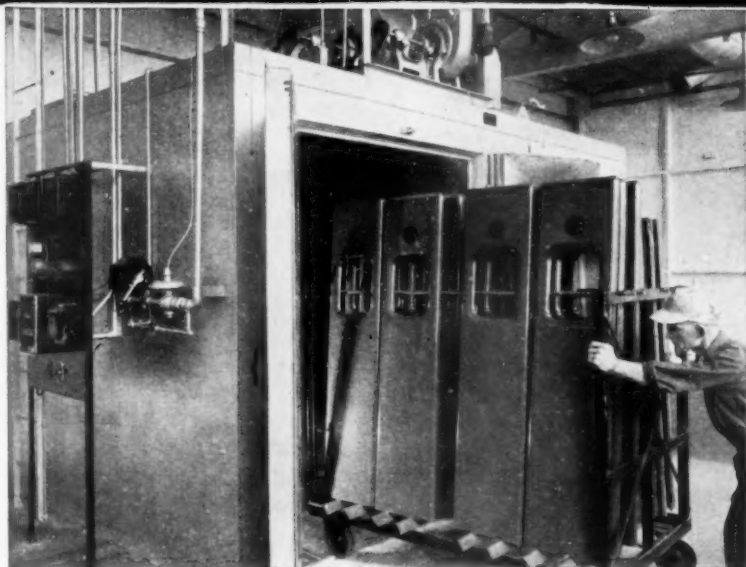
You are undoubtedly familiar with the fact that in using either type of centrifugal that the work is first dipped into lacquer and the surplus is whizzed off in the centrifugal.

In one type of machine, the dipping tank is self-contained whereas in another type, the lacquer pot is outside of the centrifugal and then the dipped work is poured into the centrifugal basket.

In either case, the surplus lacquer is whizzed off and the work dried in the centrifugal. After it has dried, anywhere from two hours to overnight, it is dipped rapidly in bulk, using a perforated basket, into a tank of gold dye, then into a warm water dip and a cold water dip, then into hot sawdust where the work is dried.

This method should produce the desired color and be very economical.
—G. K.

KIRK & BLUM INDUSTRIAL OVENS



BAKING TIME CUT 25% . . .

When the Dayton Pump Company, Dayton, Ohio, decided to replace an old steam oven with more modern equipment, Kirk & Blum Engineers were called in to do the work.

To meet the specific requirements involved, the Kirk & Blum Batch Type Oven (left)—for finishing pumps, either knocked down or assembled—was designed, built and installed.

This oven handles 5000 pounds of work per charge; operates from 200 to 500 degrees F.; saves twenty minutes out of every hour when compared to the time required by the old oven. It is automatically controlled and fully protected by latest, approved safety devices. Fresh air is taken from the outside of room.

Kirk & Blum Engineering Service is available upon application. Write for complete details and valuable data on baking, drying, enameling operations—no obligation.

THE KIRK & BLUM MFG. COMPANY • 2859 Spring Grove Avenue, Cincinnati, Ohio

Chicago Representative—C. P. Guion, 1661 N. Milwaukee. Pittsburgh—Bushnell Mch. Co., 311 Ross St.
Louisville—Liberty Eng. & Mfg. Co., Inc., 1450 S. 15th St.

ORGANIC FINISHING DIGEST

PATENT AND LITERATURE REVIEWS

Electrodeposition of Synthetic Resins

*An Extended Abstract**

By Carl Schaefer

*Chemist, Casco Products Corp.,
Bridgeport, Conn.*



Carl Schaefer

The deposition of organic materials from aqueous suspensions, especially of rubber, has been known for several years. The corresponding process, however, of deposition from non-conductive hydrophobic media is relatively new. It was in the course of an academic investigation that it was found that resinous electrolytic deposits obtained from such suspensions possess sufficiently high insulating qualities to warrant the development of a method for depositing upon metals insulating resins for industrial purposes.

The use of insulating liquids, chiefly mineral oils, as the dispersing phase of the suspensions has the advantage of avoiding complications due to harmful electrolytic products. The deposition continues without water being enclosed between the solid particles of the deposit—a condition which is necessary if the good insulating qualities of the deposit are to be insured.

Four synthetic resins were used: polymeric styrene, methyl methacrylate polymer, butyl methacrylate polymer and an alkyd modified urea-formaldehyde resin. The latter is of the thermosetting type while the first three are thermoplastic. Each resin requires individual treatment in preparing the necessary suspensions. In general, fairly stable suspensions can be prepared by slowly precipitating out the resin from its solution in an organic solvent by an excessive addition of a mineral oil in which the resin is insoluble. The ratio of solvent to mineral oil precipitant is important and is in the range of 1:2 to 1:3. A small volume of a standard solution containing 10% of the resin in xylene, phenol or chloroform is diluted with its respective solvent and then a larger volume of the mineral oil is added. With polymeric styrene resin, this is kerosene; methyl methacrylate polymer and butyl methacrylate polymer resins are precipitated with a paraffin oil [Merusol of the Standard Oil Company (Indiana)] while with the alkyd modified urea-formaldehyde resin, the Superla #9 mineral oil from the same source is used. These suspensions remain stable for about one day. The concentration of solids in the final suspension is very low (about 0.5%) as compared with a 35% solids content in the latex mix used for the electrodeposition of rubber.

The electrodeposition process was carried out in cylinders for coating copper wire 1 mm. in diameter and in flat containers

where small condenser plates were coated. In each case the container was used as outer electrode with the work as inner electrode. In polymeric styrene suspensions, the particles were negative, in the other three, positive. Accordingly, the electrode to be coated, was in the first case, positive and in the other three, negative. As in rubber deposition, the suspended particles are coagulated by neutralizing ions liberated from the anode; in the cases where the particles are positively charged it seems that electrons emitted from the cathode can play the same role as ions. The metallic nature of the work does not seem to be of much importance. The work was cleaned in nitric acid and in benzene before depositing the resin and the adhering oil wiped off the layer of resin after completing the deposition. Only the thermosetting alkyd modified urea-formaldehyde resin deposits required further curing treatment at 180°C to make them insoluble.

A rectifier set providing up to 2000 volts was used. Since the process is essentially electrostatic and no power has to be delivered apart from losses, the generator unit can be quite small. The effects of voltage and time on the thickness of the deposit are, within limits set by the nature of the process, similar to those in metal plating or in the deposition of rubber. The solids concentration in the bath is quite low and since there is no means of automatically replenishing the bath and keeping its concentration constant, it very shortly becomes depleted and deposition halts. Hence the thickness obtainable ultimately depends upon the size of the container and the total amount of liquid present. The maximum thickness of deposit obtained in the experimental containers was about 4 mils. However, by renewing the suspension after the first layer had been produced, deposition could be

continued and in this way deposits up to 8 mils thick were easily obtained. With the polymeric styrene resin it was found feasible to regenerate the exhausted mix by the addition of another small amount of standard solution with some solvent to replace that lost through evaporation. Thus four deposits were obtained from the same basic suspension, giving a possible means of making the process continuous.

The voltage most frequently used was 200-250 volts. With this pressure 3-4 mils required 20-25 minutes. From the theory that the cataphoretic velocity is proportional to the electric field, it would follow that for a given container, the time required for a given thickness should be inversely proportional to the voltage. This was found to be true with the polymeric styrene resin since by raising the voltage from 200 to 1000 volts only 3 minutes were needed to produce a 4 mil deposit. The deposition is linear up to 2 minutes—beyond this point it decreases as the mix becomes exhausted.

With the other three resins, an additional effect interferes with the cataphoretic one making it impossible to use higher voltages to reduce the time. Above 300 volts, the thicknesses of the other deposits decrease because of dielectric displacement. That is, the component with the higher dielectric constant accumulates at the points of higher field strength, and where the liquid phase consists of chloroform with a constant of 4.7, it tends to replace the solid near the work and destroy the deposit. The solvent for the polymeric styrene resin is xylene which does not exhibit this effect, but with the methyl methacrylate polymer, butyl methacrylate polymer and alkyd modified urea-formaldehyde resins the liquid phase consisted partly of chloroform in this investigation. For these resins, therefore, the maximum safe voltage is about 250 volts and it becomes necessary to replace the chloroform with some suitable solvent of lower dielectric constant before deposition can be made more rapid.

The physical properties of the deposits are very similar to those of the pure resins. Thus polymeric styrene layers are rather brittle, methyl methacrylate polymer deposits fairly flexible and butyl methacrylate polymer deposits are somewhat sticky. All of them probably contain traces of oil. The most satisfactory deposit from the mechanical standpoint is the alkyd modified urea-formaldehyde resin deposit, which after curing is hard yet very flexible.

* Abstracted from "Electrodeposition of Synthetic Resins," by Andrew Gemant, Ind. and Eng. Chem., October, 1939.

The results of the electrical breakdown tests and dielectric loss angle measurements indicate that the deposited resins are satisfactory as concerns their electrical insulating properties. The electric strength of alkyd modified urea-formaldehyde resin deposits does not decrease after a coated wire is bent over a curvature radius of 0.4 cm. This is a good check for flexibility and insulation.

The brittleness of a resin can be reduced by adding to the mix a plasticizer such as dibutyl phthalate which is probably adsorbed on the resin during deposition. This increases the flexibility along with the breakdown strength up to a certain point. Further addition of plasticizer decreases the strength as the deposit becomes too soft. A small amount of the plasticizer (about 0.5% volume in the mix) seems to be best.

Brevities

To the layman, the word "synthetic" frequently refers to something inferior in quality to natural products. To the chemist, however, a synthetic product may be of higher purity and quality than a natural product. The writer approached one of the automobile salesmen at the recent New York Automobile Show, and inquired whether the finish used was synthetic baked enamel or lacquer. The salesman, in horror, stated that there was nothing synthetic in his entire car.

I did not stop to point out that nitro-cellulose lacquers, the plastic parts, the alloy steels, the aluminum alloys used in the engine, the rubber and almost the entire car were "synthetic" products of research by chemists or metallurgists.

The problem whether an employer can use the secrets of another company imparted to him by a new employee is under consideration in the U. S. District Court in Ohio. The Interchemical Corp., Cincinnati, Ohio, has filed a motion seeking dismissal of a suit filed by the Oxford Varnish Corp. of Detroit, Mich., involving just such a problem.



BE MORE SPECIFIC MR. WEBSTER!

Even the best word umpire occasionally exposes himself to a pop bottle barrage. Witness this definition by Webster: "FINISH—a material used in finishing . . ." That may have sufficed in the days of 'way back when' but in this streamlined age—never! Providing sturdy sales legs for products in the form of coatings that measure up to SPECIFIC requirements—coatings that look better, wear longer, reduce finishing costs—is Stanley's place in your production picture. Possibly the Stanley Laboratory already has developed the coating that is the perfect answer to your particular problem. Address Department K—

THE STANLEY CHEMICAL CO.
EAST BERLIN CONNECTICUT
Lacquers · Enamels · Synthetics · Japans
A SUBSIDIARY OF THE STANLEY WORKS, NEW BRITAIN, CONN.

FILTERS

Capacity—200 to 2400 Gallons Per Hour

FOR:—

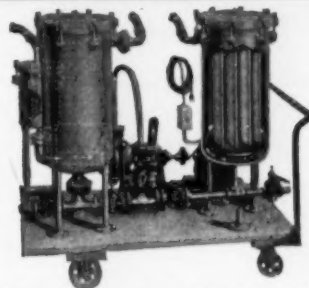
- BRITE NICKEL PLATING SOLUTIONS
- ACID & CYANIDE PLATING SOLUTIONS
- HOT SOLVENTS IN DEGREASING MACHINES
- OLEUM SPIRITS, NAPHTHA, GASOLINE & OILS
- LACQUERS, LACQUER THINNERS & ALCOHOL
- ALKALINE CLEANING SOLUTIONS & NEUTRALIZERS

Many important benefits are derived, and big savings effected in metal cleaning and finishing operations, as a result of filtration.

Industrial Filter & Pump Mfg. Co.

3017 West Carroll Avenue

Chicago, Ill.



Cut illustrates both closed and internal view of typical filter.

AUTOMATIC FEEDER & MIXING TANK for HYFLO Filter Powder. RECOMMENDED for operation with any make of Filter on large plating tanks of 2000 gallons or more capacity.

For specific recommendations, mention kind of solution, number of gallons, etc. Write for our new bulletin and descriptive literature.

NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

New Process Copper Powder

The Edward C. Ballou Co., 6 Varick St., New York City, announces a new process copper powder which when used in connection with high-bake synthetic vehicles, claims to produce a very close imitation of a real copper-plated finish.

This process is reported to be far superior to the ordinary copper bronze powders, both in covering qualities and brilliancy.

A sample will be forwarded on request, with suggestions as to proper vehicles to be used.

Syphon Feed Covers for Cans

Burning Brand Co., 1400-16 W. Fulton St., Chicago, Ill., has developed a syphon feed cover for friction top cans. The cover is said to fit standard quart size friction top paint cans, and this cover will enable different colors to be stored in the original



Syphon feed cover for cans.

can, thus obviating the necessity for using separate material cups for each change of color.

This can, with other spray painting equipment, is described in a folder recently released by the Burning Brand Company.

New Wrinkle Finish

New Wrinkle, Inc., Dayton, Ohio, licensors of wrinkle finishes under patents held by the company, have recently developed what is known as the "New Wrinkle" dip-process of castings finishing.

The casting is dipped in a thin solution of this finish, which claims to insure complete coverage for all exposed to-the-eye

surfaces, and securely seal all the pores on hidden surfaces. It is then placed on a slightly inclined, removable screen-covered rack so the surplus paint is collected in a tray which returns it to the dipping tank. By racking the castings in this manner and letting them stand for several minutes, the finish is given an opportunity to set. The casting is now ready for a quick spraying, which is said to be accomplished with a minimum of waste as the atomized material readily adheres to the wet casting surface.

The finish, the manufacturers state, provides both an attractive appearance and a hard surface that cannot be marred very

easily. Its effects range from the small "fish-eye" wrinkle of fine texture to the "pine tree" wrinkle dependent upon the desire of the user.

This process of castings finishing may only be applied in connection with the use of "Wrinkle Finishes". This is revealed through the recent filing of patent applications in the U. S. Patent Office. It automatically is released to castings users through the purchase of these finishes from any of the licensees of the company who, under their license, manufacture and distribute these finishes.

Special One-Dip Type Degreaser

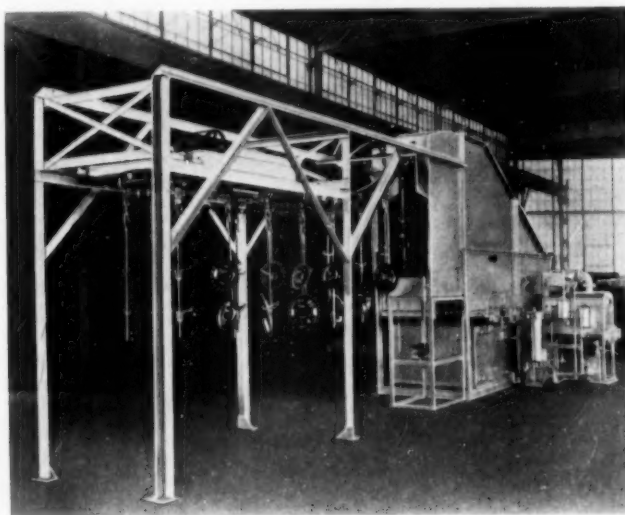
Outstanding operating and maintenance economies are claimed in the cleaning of various types of metal parts by the features incorporated in the one-dip, or liquid-vapor design of degreaser illustrated herewith. This machine is an addition to the complete line of metal cleaning and finishing equipment manufactured by Detroit Rex Products Co., 13005 Hillview Ave., Detroit, Mich.

In addition to the usual high speed pro-

cesses, the machine is designed to be used once every two and a half months, in spite of taking care of the cleaning of a very high production. The solvent still and filter remove all oil and insoluble contamination so that the boiling chamber is always full of clean solvent.

The cleaning cycle consists of immersing the work in boiling solvent and passing it through solvent vapors. At the exit end of the degreaser, there is a light oil spray system that can be used to rust proof the work as is desirable when it is to be placed in storage for any length of time.

The return-type conveyor system is completely self-contained with the load and unload stations extending approximately 19' from the machine. The work is lowered on special fixtures, which handle about a dozen wheel disc inserts each. Rolling and stamping oils and insoluble materials are removed from these parts in the degreaser; the operation being cleaning prior to casting of wheels around insert discs.



One-dip type degreaser with solvent still and filter.

duction cleaning with minimum space requirements that is typical of all degreasing installations, this new design is said to have exceptionally low maintenance requirements combined with thorough cleaning in spite of the heavy carry-in of dirt, metallic chips and oil. These economies have been effected largely through the use of a continuous solvent still and filter. This machine is said to require cleaning only about

The solvent in the machine is heated by steam coil mounted in the removable clean-out door, and there is also a steam jacketed bottom on the boiling compartment. This combination of steam coils and jacket gives the boiling solvents a vigorous rolling action which completely removes insolubles from the work. All steam connections are tested for a pressure of 40 lb. per sq. in., and the steam jacketed bottom is equipped

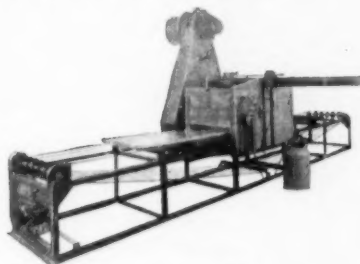
with a pressure relief valve set at 15 lb. per sq. in.

This design of machine is manufactured in a wide range of sizes and capacities.

Automatic Airpainting Unit

Paasche Airbrush Co., 1909 Diversey Parkway, Chicago, Ill., has announced the development of an automatic airpainting unit with a 32" stroke, air-operated oscillating arm.

This unit has been developed for coating metal tile squares automatically.



Automatic airpainting unit.

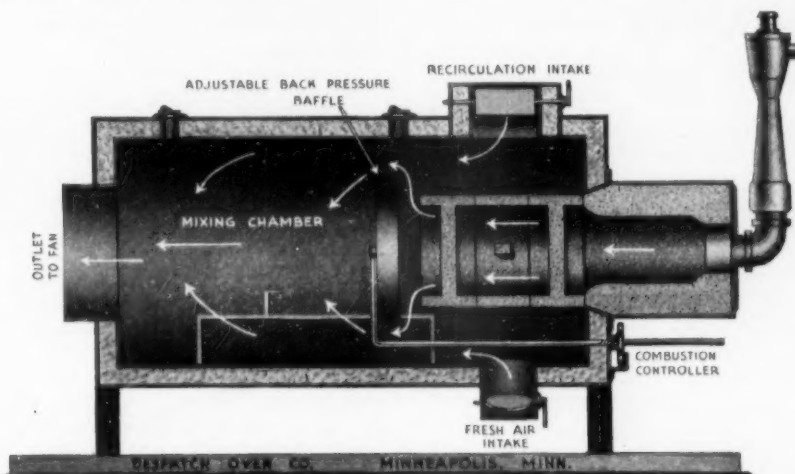
A steady continuous production is claimed to be readily obtained from this unit of over 1800 metal tile squares per hour.

The two automatic airguns automatically oscillate back and forth and apply the exact amount of material wanted, it is stated. The unit is 21' long, 3' wide, 2' 6" high and the speed of conveyor is variable from 2½ to 5 lineal feet per minute. It comes complete as illustrated, with ventilating duct, fireproof ventilating unit, pressure feed material tank and enclosed coating station.

Direct Gas Fired Externally Mounted Heater

Despatch Oven Co., Minneapolis, Minn., has announced the development of novel, direct gas-fired, externally mounted air heaters, employing a controlled combustion feature.

These new heaters are said to combine high operating efficiency and flexibility with durability, safety and simplicity. They are recommended for all heating operations from 100° F. to 1250° F., where the products of combustion are not objectionable.



Direct gas-fired externally mounted heater.

ORGANIC FINISHING SECTION

EGYPTIAN FINISHES

EGYPTIAN HIGH BAKE N. F. R.—

A tough mar-proof chemically resistant synthetic finish for all types of metal products.

EGYPTIAN ZINC CHROMATE PRIMER—

An excellent rust inhibiting undercoat. Dries rapidly at room temperature. Can be used in multi-coat single bake systems. For exterior and interior use.

EGYPTIAN PERSPIRATION RESISTING LACQUER—

Offers unusual resistance to body acids encountered by frequent handling. Produces a hard film, extremely durable to wear and tear.

EGYPTIAN FINISHING LACQUERS—

For use over colored enamels. Tough, light colored lacquers which withstand buffing to extremely high quality finish. Extremely resistant to handling.

EGYPTIAN FLEXIBLE CLEAR LACQUERS—

Air-dry clear lacquers for use on sheet metal which is later to be formed into the finished article. Excellent adhesion to brass, aluminum, lead, copper, oxidized copper and steel. Tough and extremely durable.

These and numberless other lacquers, both clear and pigmented, as well as synthetic finishes are available to the trade for all types of finishing. We will be glad to furnish further details upon receipt of your request.



THE EGYPTIAN LACQUER MANUFACTURING COMPANY

Rockefeller Center
New York

The units are claimed to be easily installed, operated and maintained, and eliminate the smell from incomplete combustion and unburned gases. This feature is claimed

to make them an ideal heater for both old and new ovens, dryers, etc., for synthetic enameling, japanning, lacquering, etc. The heater can be used for processing, of volatile or inflammable materials, in open or closed air circuits as required for the process and application.

Cleanliness is another feature claimed for these air heaters. From the illustration it may be noted that the alloy steel baffle is mounted on suitable guide rails and is interconnected to a threaded rod that runs to the front of the heater. By means of a knurled knob, the distance between the end of the combustion chamber and the baffle can be increased or decreased to meet each operating condition. In other words, back pressure set up in the combustion chamber may be positively regulated, so maintaining proper combustion temperature, proper induced draft, and maximum combustion efficiency under each operating requirement.

Further details and literature can be secured by writing to the Despatch Oven Company.

Manufacturers' Literature

Abrasive. Data Sheet No. 2, devoted to "Boroblast", aluminum oxide abrasive grain for pressure blasting applications, containing information on production, grain size, inspection, packing, etc. Abrasive Co., Philadelphia, Pa.

Air Heaters. Bulletin 74 outlines briefly the history of indirect air heating, giving information on the design and construction of the new "Despatch" heavy duty indirect air heaters. They are recommended for the following: baking ovens, space heating, dryers and dehydrators, curing ovens and kilns. Despatch Oven Co., Minneapolis, Minn.

Finishing Methods. A comprehensive review of the various methods of applying lacquers and enamels to metal products. Copies of this review, which was presented by G. Klinkenstein, vice-president and technical director of Maas & Waldstein, before the recent annual convention of the American Electroplaters' Society, are available on request. Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.

New Wrinkle, Inc., Dayton, Ohio, licensors of Wrinkle Finish, announces the appointment of Allied Finishing Specialties Co., a division of Chicago Bronze & Color Works, 841-45 Larrabee St., Chicago, Ill., as licensee for the manufacture of this finish; also the St. Louis Surfacers and Paint Co., 4200 Arlingtong Ave., St. Louis, Mo.

Paint—High Temperature. Bulletin on "Kemick", a chemical rust-preventing paint for metal surfaces that are subjected to high temperatures, and which claims to stay

"put" even though the metal gets red hot. This paint is suitable for use on steel, iron, copper, brass, aluminum and zinc or galvanized iron at temperatures below their melting points. American Chemical Paint Co., Ambler, Pa.

Paint—White Lead. This booklet contains a description of the composition of pure white-lead paint and explains the nature and purpose of each ingredient used. It discusses interior painting, the use of tinted paint on exteriors and interiors, and helpful hints on paint mixing and paint application. Published by the Lead Industries Association. A free copy may be obtained by forwarding a request on business letterhead to the Editor of Dutch Boy Quarterly, Rm. 2020, 111 Broadway, N. Y. City.

Porcelain Enamel. A folder giving a brief story of a severe porcelain enamel test, which is said to have proved that "Pemco" porcelain enamel is suitable for all requirements of under-water vehicular tunnels. Porcelain Enamel & Mfg. Co., Eastern & Pemco Aves., Baltimore, Md.

Spray Equipment. A circular on a combination spray unit (P-1 gun and compressors), which can be used for spraying of insecticides, germicides and other liquids as well as paints, lacquers and varnishes. Andrews Spray Equipment Co., W. 9th and Superior Ave., Cleveland, Ohio.

Spray Equipment. A circular describing Type KSR radiator core and touch-up spray gun; air nozzles and Type KSC oil spray gun. Alexander Milburn Co., 1416 W. Baltimore St., Baltimore, Md.

Thermometers. A colorful booklet featuring a new line of thermometers and pressure gauges, which describes the vapor-actuated, gas-actuated and mercury actuated types of the Brown Instrument Co., Philadelphia, Pa.

Ventilating Equipment. More than 200 axial flow pressure fans, ranging in size from eight inches to ten feet, are included in a new illustrated catalog issued by the De Bothezat Ventilating Equipment Div. of American Machine & Metals Inc. Copies of the catalog and price lists may be obtained by writing to De Bothezat, East Moline, Ill.

Wrinkle Enamels. A technical bulletin describing the properties and applications of "Duart" wrinkle enamels, spraying conditions, baking schedules, coverage, methods of patching, and other pertinent data are given. Maas & Waldstein Co., Newark, N. J.

Wrinkle Finishing. A folder introducing the "Dipspray" process to castings finishing. The following results are claimed: doubles production of finished castings; assures complete surface coverage to seal casting pores against rust; eliminates rejects which average 20% under ordinary finishing conditions. New Wrinkle, Inc., Dayton, Ohio.

KREIDER Centrifugal DRYER

For Drying All Types of Plated Work and Lacquering Small Parts

Speeds Up Production . . . Cuts Costs . . . Improves Quality



The new Kreider Centrifugal Dryer reflects our many years' experience in this field. It is the result of our engineers' effort to produce the best. Although unusually simple in design and easily operated by one man, the Kreider Dryer speeds up production and improves the quality of the work.

An auxiliary steam heating unit can be supplied as standard equipment when drying parts which have a tendency to retain water and additional steam is needed in the drying operation. Reversing drum switch is supplied on all dryers.

Write for Complete Specifications and Prices

DELLINGER MANUFACTURING CO.

727 North Prince Street
Lancaster, Pa.

ENTHONE

BAKED ENAMEL STRIPPER


Baked enamels removed swiftly and cleanly. No smut—no pigment deposits to wipe off.

Economical—Use 3 parts water—1 part stripper. Enthone Stripper is not consumed during stripping and drag-out is only loss.

Non-Corrosive—No attack on aluminum, magnesium, zinc or other metals.


Glyptal, urea-formaldehyde, resyl, bakelite, and other baked enamels often stripped in less than a minute.

Write today for a sample and information for cutting your enamel stripping costs.

The ENTHONE Co.  **Chemical Products**

NEW HAVEN, CONN.

BOTH with m&w **CODUR ENAMELS**



Your Products can now be finished quickly without sacrificing quality.

Your Products can now have the hardest finish, with the best color retention.

Codur Enamels produce an exceedingly durable and beautiful finish in a remarkably short time. Here are some of their special features:

- Developed for use in high-grade products subjected to severe service conditions, such as refrigerators, washing machines, kitchen cabinets, etc.
- Dry out of dust rapidly, cutting down both finishing time and dirt spoilage.
- Bake in five minutes at 350° F., 1 hour at 250° F.
- Baked finish is exceedingly tough and resistant to marring, moisture, and action of household chemicals.
- Excellent adhesion, color retention, and flexibility.
- Cover well in one coat.
- For use on all metals and Bakelite.
- Supplied in white, black, and a wide range of colors, with and without metallic lustre.

A Technical Data Sheet on Codur Enamels is now available. Data includes grades, application and reduction instructions, baking schedules, specifications for finishing steel cabinets and furniture and metallic finishes on metals, and other information that the practical finisher wants. Send for your copy.

Maas and Waldstein Company, Newark, N. J.

Branch Offices and Warehouses . . . 1336 Washington Blvd., Chicago . . . 1228 W. Pico Blvd., Los Angeles

LACQUERS PIONEERS IN PROTECTION ENAMELS

WALKER'S Chlorinated Rubber Finishes stand every TEST - 100 per cent !

This outstanding new finish, developed at the Walker laboratories, is used on metal over a primer. Used with highest satisfaction on metal objects requiring a good durable finish.

Applied by spray, or dipping. Here are a few strong points:

- ☞ Has drying qualities of lacquer. — Whether air dried or force dried, the sterling qualities in these finishes are never destroyed.
- ☞ Has extreme outdoor durability. Positively resists acids and alkalies.
- ☞ Gives a high gloss, or can be modified to a dull finish.
- ☞ Is not high priced. We assure prompt deliveries.



Walkers Chlorinated Rubber Finishes can be used to good advantage on your product.

LET US SEND
DETAILS AT
ONCE

H.V. WALKER CO.

FINISHES TO FIT YOUR PRODUCT

Offices
and Plant

ELIZABETH, N. J.

New England Representatives, BROWN & DEAN CO., Providence, R. I.



The Emblem
of Quality
in Finishes

Agateen LACQUERS

All types of Clear Lacquer for Metals

BUFFING LACQUER

for Cloisonne Reproductions

Air-Dry Priming Lacquer

Water Dip Lacquer

Elastic

Non-blushing

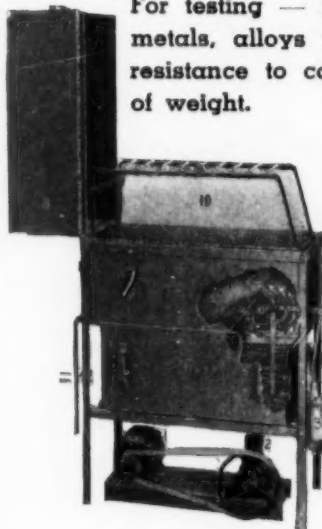
Agate Lacquer Mfg. Co., Inc.

11-13 Forty-third Road,
LONG ISLAND CITY, N. Y.

Agateen —The Last Word in Quality

SALT SPRAY TESTING EQUIPMENT

For testing — Electroplated & coated metals, alloys & Paints to determine resistance to corrosion, pitting & loss of weight.



The U. S. Bureau of Standards recommends Salt Spray test for this type of examination.

Units are made in two Standard Sizes — Test cabinets measuring—23" high x 12" wide x 26" long & 29" high x 14" wide x 33" long.

A test of just a few hours in Salt Spray compares with many months test in the open. Effect big savings by testing different plating on production parts.

INDUSTRIAL FILTER & PUMP MFG. CO.

3017 W. Carroll Ave.

Chicago, Ill.

Personals

Frederick Gumm was married on Wednesday, November 1st and has been receiving the congratulations of his many friends in the industry.



Frederick Gumm

Mr. Gumm has had many years of experience in plating and the cleaning business, and in June 1930, formed the Hess-Gumm Company, which later became the Frederick Gumm Chemical Company, which has its own plant in Kearny, N. J.

W. L. Cassell Becomes Equipment Sales Manager for MacDermid, Inc.

Wesley L. Cassell will shortly join the executive staff of MacDermid, Inc., Waterbury, Conn., as manager of equipment sales. He will head a new department to handle equipment sales for MacDermid. His office will be in Waterbury, and Mr. Cassell will concentrate his efforts in New England and New York State.

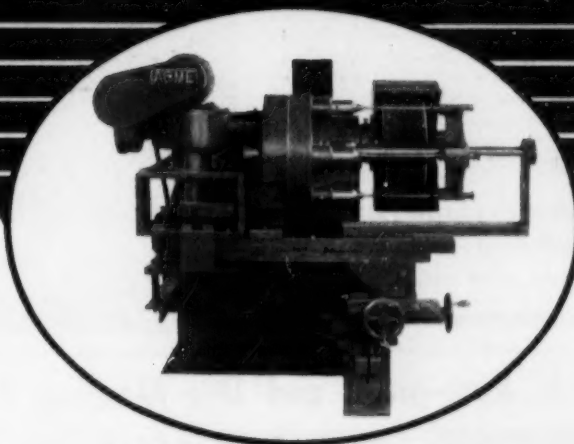
Mr. Cassell started his industrial expe-



W. L. Cassell

METAL INDUSTRY, November, 1939

SPEEDIER Polishing *and* Buffing *at* Lower Cost!



Modernize With An "Acme"!

Put your polishing and buffing operations on a more economical and efficient basis. Acme equipment will turn out a higher grade of work, do it faster and at lower cost.

Illustrated above is one of the many types of Acme machines—a 4-spindle automatic indexing machine, with stroke, combined with a buffing lathe, designed especially for the finishing of articles several inches in diameter and up to 12 inches in length. Whatever your problem may be, the chances are that there's an Acme machine that will solve it.

Send Sample
today for

FREE

Production
Estimate

ACME Manufacturing Co.
1642 HOWARD ST. • DETROIT, MICH.
Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

rience with the General Electric Co., spending three years at Pittsfield, Mass., and one year in Schenectady, N. Y. He left G. E. to go with the Carbon Products Division of the National Carbon Company, where he spent eight years in travel for this company. He later was transferred to the general sales department of the National Carbon Company in New York, where he was engaged in special investigation work on battery applications and radios.

In 1928, Mr. Cassell opened the New York office for the Udylyte Process Co., Inc., as it was then known, and he has been with the Udylyte Company until he went with MacDermid this month.

Frank K. Foy, formerly Connecticut representative of MacDermid, Inc., has been advanced to the position of field manager of industrial cleaner sales, covering the New England territory, Metropolitan New York, New Jersey and Pennsylvania.

William H. Jewell, for the past twenty-three years associated with the Ingersoll-Rand Co., has been appointed general manager of its Athens, Pa., plant. Mr. Jewell succeeds *John M. Felt*, resigned. The firm operates the following departments: pickling, welding, sand-blasting, polishing, cleaning, tumbling, buffing. The principal base metals used are: steel, bronze and aluminum.

WE GRAFTED SKIN TO METAL

Paper-Adhered — an exclusive American Nickeloid development that protects the lustrous finish of American Bonded Metals during unusually severe production processes. Affords absolute protection to their mirror-like finishes from warehouse through completed fabrication . . . peels off as easily as a banana skin. A development that makes possible the production speed and economy of *pre-finished* metals despite the severity of your manufacturing process. Write on your company letterhead for illustrated brochure.

AMERICAN NICKELOID COMPANY
8 SECOND ST.—PERU, ILLINOIS
Sales Offices in All Principal Cities



This Wash, Rust-proof and Dry Machine PAYS for ITSELF IN A YEAR



This is one of our standard wash, rust-proof and dry machines, consisting of soaking wash, spray wash, drain, oil spray, drain and dry. Will handle 900 lbs. of product per hour. For details of this and other Ransohoff Equipment, write for Catalog 40.

N. RANSOHOFF, INC. • 282 W. 71st Street, Carthage • CINCINNATI, OHIO

A nationally prominent bolt and nut manufacturer reports:

"Since installing the Ideal Continuous, wash, rust-proof and dry machine for metal parts, it has saved sufficiently to pay for itself in one year's operation. The work is finished better than with older methods, and at greater speed and considerably lower manufacturing cost."



COMPLETE FILTER SYSTEMS, FILTER MATERIALS AND ACCESSORIES FOR PLATING SOLUTIONS, DEGREASING SOLVENTS, ETC.

Circulating pumps of Duriron, Hard Lead, Steel or Iron.

Filter Baffles for interchanging or replacement of Molded Rubber, Cypress Wood or Steel Wire Mesh.

Filter Bags or Cloths of Woven Wool, Cotton or Cloth of Synthetic material for Chromium and Acid Copper.

Rubber Hose for Hot or Cold Plating Solutions.

Filtering Materials:—Hyflo for Nickel Solutions; No. 503 for Cyanide Zinc, Cadmium and Brass, or Nickel solutions treated with carbon; Fibred Asbestos for Pre-coating; Activated Carbon, and purifying clays for Plating Solution and Solvents.

Constructive suggestions, specifications or recommendations will be gladly submitted upon request.

INDUSTRIAL FILTER & PUMP MFG., COMPANY
3017 W. Carroll Ave. Chicago, Ill.

Verified Business Items

Al Payson who is well known in the plating and finishing industry announces that he has become sole owner of the *Michigan Buff Co.*, 4054 Beaufait Ave., Detroit, Mich. having purchased all outstanding stock.

Rex Body and Fender Co., 1431 W. 28th St., Cleveland, Ohio, automobile bodies and sheet metal automotive products, has asked bids on general contract for a one-story addition, 62 x 140 ft. Cost close to \$50,000 with equipment. The following departments are operated: brazing, welding, lacquering, enameling and finishing.

Cecil Knights, sales representative of the *Hanson-Van Winkle-Munning Company*, Matawan, N. J., manufacturers of electroplating equipment and supplies, has been transferred from the Chicago to the Detroit office.

H. E. Moyer has been appointed Los Angeles sales representative for the *Hanson-Van Winkle-Munning Company*, Matawan, N. J., manufacturers of electroplating equipment and supplies. He is located at 4324 South Normandie Avenue, Los Angeles, Cal.

Special Products Co., 750 Main St., Hartford, Conn., metal goods, has leased a one- and two-story building, 240 x 560 ft., to be erected on Barney Place, Stamford. The first floor will be equipped for machine shop and other production divisions. Cost close to \$100,000 with equipment.

Sunset Jewelry Manufacturing Co., 1540 N. Cahuenga Blvd., Hollywood, Calif., has quadrupled the floor space of its plant by the addition of three nearby store rooms, and is completely remodeling them. One room, 38 ft. x 50 ft., will be devoted to polishing and plating gold and silver; the other two, of almost similar size, will constitute additions to the assembly and manufacturing departments.

The Toledo Scale Co., Toledo, Ohio, has announced the commencement of the manufacture of a new factory, said to be the largest plant in the world for the making of automatic weighing devices. The factory will replace the six old plants which the company had developed in its forty years of growth.

The factory covers 250,000 sq. ft. It is of steel frame type, with special adapted steel roof trusses and walls of brick and glass. Electrical current at 440 volts is transmitted through the entire area by bus ducts, so that electrical units may be instantly connected at any point.

The plant is entirely complete as a manufacturing unit, from its own boiler plant serviced by a railroad siding to the large area devoted to research and experimental work.

Reliable Barrel Co., 1443 E. 40th St., Cleveland, Ohio, steel barrels, drums, etc., has leased property for a new plant at Grant Ave. and E. 49th St. consisting of about 1½ acres, improved with a one-story building. The present works at address first noted, will be removed to the new location and capacity increased. The company will continue operation of other local plant at 2370 E. 67th Street, as heretofore. Departments operated: brazing, welding, cleaning, tumbling, lacquering and enameling.

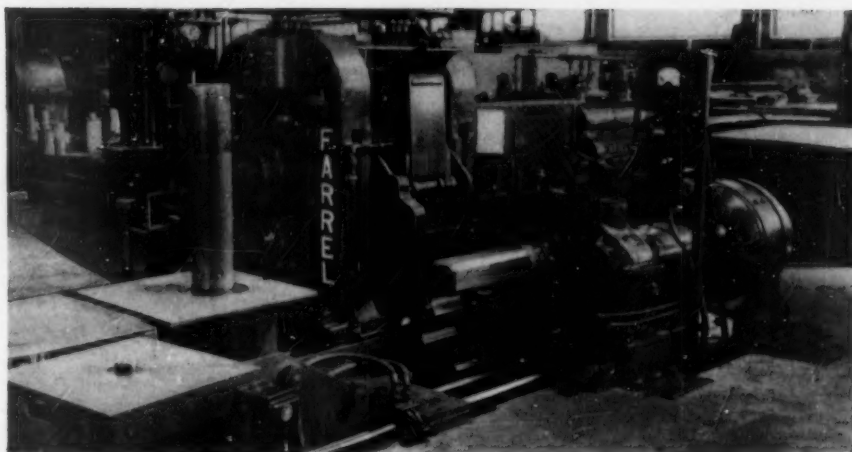
H. K. Porter Co., Inc., 49th & Harrison Sts., Pittsburgh, Pa. known for more than 70 years as manufacturers of industrial and switching locomotives, recently have expanded their activities by the establishment of a separate division for the design and manufacture of many types of processing equipment, including ball and pebble mills, tube mills, agitators, mixers, blenders, autoclaves, kettles, tanks, etc. Several of these products incorporate new features of design and construction.

Weiser Manufacturing Co., 8635 Otis St., South Gate, Calif., has a Fall program which includes the purchase of some \$10,000 to \$15,000 worth of equipment for outfitting its lock department, plating room, machine shop and assembly section. The firm, which specializes in hardware specialties and brass and aluminum castings, expects to have the new equipment installed by the first of the year. Also being purchased are a four-punch press, new lathes, tools and dies for manufacturing a new type of bore-in lock for which the company received its patents late in September.

Martin Electric Company, producers of welding transformers, air operated welding guns and special electrical welding equipment, has moved into its new plant located on Outer Drive, Detroit. Space vacated at the former Piquette Avenue plant has been taken over by **Progressive Welder Company** and is being used for expansion of manufacturing facilities for the latter company's hydraulic and air operated welding equipment.

Cannon Electric Development Co., 420 East Ave. 53, Los Angeles, Calif., is engaged in a \$20,000 expansion program which includes the construction and equipping of a machine shop and installation of a plating plant for work on nickel, cadmium, copper, brass and chrome. No addition of floor space is involved in the work, since the new departments are being placed in space hitherto used for storage purposes.

The **Porcelain Enamel & Manufacturing Co.**, Baltimore, Md., has announced the appointment of **Harold G. Wolfram** as vice-president. Mr. Wolfram has been with Pemco for the past fifteen years and has served as laboratory technician, director of research and more recently as factory manager. In his new position he will have charge of all engineering and technical activities of the company. **Walter B. Wessels**, formerly assistant treasurer, has been appointed secretary. Mr. Wessels has been with the company for several years and is well known throughout the enameling industry.



FARREL CONSTANT TENSION REELS

**Improve Strip Quality
Increase Mill Output
Reduce Rolling Cost**

In the cold rolling of metal strip efficient winding of the finished strip is an important factor in the quality of material, rate of output and production cost.

The Farrel Tension Reel with Jaw Type Wrapper, Stripper and Up-Enders illustrated above is one of several types of reeling equipment we make to facilitate winding and subsequent handling. It provides constant tension under positive control from empty to full reel, keeping the metal flat and straight and maintaining uniform gauge.

The reel drive is an enclosed herringbone gear reduction unit

with the low speed shaft extended in the form of a spindle on which either a solid or collapsible reel is rotated for winding the strip. Close control of tension is accomplished by automatic regulation of current input to the motor. All controls are conveniently located within easy reach of the operator.

The recent installations of thirty-three Farrel Constant Tension Reels in eight plants, with a high percentage of these repeat orders, is the best indication of their successful operation.

We make various types of reels designed to fit specific requirements and shall be glad to tell you how they can be applied to your rolling mills to give you the advantages of improved quality, increased output and lower cost.



FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.

New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

He brings to his new position 20 years of executive experience.

("The Influence of Microstructure Upon the Process of Diffusion in Solid Metals", concluded from page 523.)

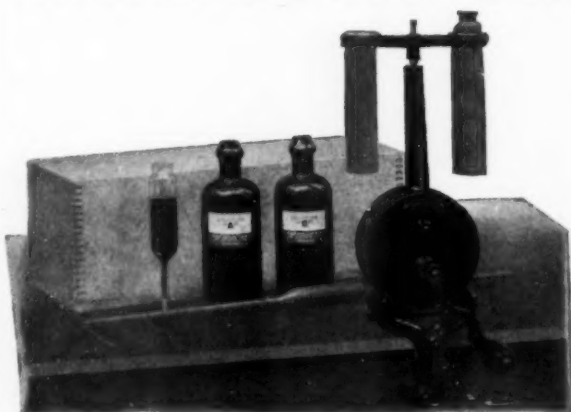
grain size than into a steel having a larger grain size.

Since the rates of diffusion and decarburization should be similar in respect to their dependence on the microstructure, the authors conducted the first tests by decarburizing steels. Impurities in steel may cause a difference in the rates of diffusion of carbon. In order to overcome this difficulty, samples from the same piece of steel were used. To develop a large grain size, one sample was heated to 1125° C for a half hour in dry hydro-

gen, in which atmosphere, no decarburization takes place. The sample was cooled to 925° C, the diffusion temperature. The second sample was placed in the furnace at 925° C and both were held at this temperature for 24 hours in a moist hydrogen atmosphere. One set of samples treated in the above-described manner was allowed to cool in the furnace and another set was quenched. The widths of the ferrite bands in the slowly cooled samples upon examination were found to be almost identical. Hundreds of measurements were made and it was found that the width of the ferrite band in the coarse grained steel was 0.0145" and in the fine grained steel was 0.0150". This indicated a slightly faster rate of diffusion along grain boundaries than across the grains.

Another experiment was carried out us-

CHROMIUM PLATERS



KOCOUR SULFATE TEST SET

KOCOUR CO. 4720 S. CHRISTIANA AVE.
CHICAGO, ILL.

**CONTROL
YOUR SOLUTIONS
AND PLATE MORE
EFFICIENTLY!**

*Write for full
information*

Testing sets for most
plating solutions

Write us or call your
jobber

ing an iron alloy of high purity containing 1 per cent carbon and 0.15 per cent aluminum oxide. The aluminum oxide was used to retain the fine grain size (128 grains per square millimeter) at the diffusion temperature. Another experiment proved that the aluminum oxide had no effect on diffusion rates. The large grain size was produced by heating at 1050° C for 1 hour in argon and then cooling to the diffusion temperature of 910° C. After being held at the diffusion temperature for 2 hours in a hydrogen-water vapor mixture, some samples were quenched and others allowed to cool at the rate of 5 degrees C per minute. Upon examination, the widths of the ferrite bands in the fine and coarse grained steels were found to be almost identical but the total amount of massive ferrite seen in the fine grained sample was greater than that in the coarse grained sample. There was, however, a large amount of proeutectoid ferrite in the pearlite of the coarse grained steel. It is possible, then, that the total proeutectoid ferrite present was the same in both steels. As was found in previous experiments, the rate of diffusion of carbon into fine grained steel, is as fast and, if anything, faster than in coarse grained steels.

A brief study was made of the diffusion of nitrogen into iron. Evidence was obtained which seemed to show that diffusion was carried on at a faster rate in fine grained steels. The photomicrographs of the nitrided steels showed the precipitation of iron nitride to be at a greater depth in the fine grain steels. The grain boundaries may, however, have some influence on the nucleation of the precipitate.

C. T. Price, heretofore vice-president in charge of sales of the Compressed Industrial Gases, Inc., Chicago, Ill., has been made vice-president and general manager of the company. F. M. Wyman has been appointed general sales manager and R. G. Wilson, assistant general sales manager.

W. J. Adams, formerly with the Continental Roll & Foundry Co., East Chicago, Ind., has been added to the engineering staff of Gar Wood Industries, Inc., Detroit, Mich., following the recent acquisition of Continental's tractor equipment division by Gar Wood.

**FOR POLISHING
TOUGH
Shapes**

The face of a
Paramount Felt
Polishing
Wheel can be
turned to fit the
job, and it stays there! No
spreading like built-up
wheels do, requiring constant
reheadings.

Ask your supplies salesman for
PARAMOUNT BRAND.

BACON FELT CO.

WINCHESTER, MASS. ESTABLISHED 1824



BEFORE CLEANING

Aluminum Caps
—a soft metal
smeared with spinning
compound and
dirt from handling.



AFTER CLEANING

Cleaned 100 per
cent with PERMAG,
without injury to
the soft metal.

PERMAG is safe,
quick, efficient.

PERMAG Cleaning Compounds did this Cleaning job on Aluminum

Aluminum and other soft metals are quickly and effectively cleaned with PERMAG Cleaning Compounds without a trace of injury to the metal.

PERMAG Metal Cleaning Compounds are designed to successfully and economically handle any cleaning problem of the metal fabricator.

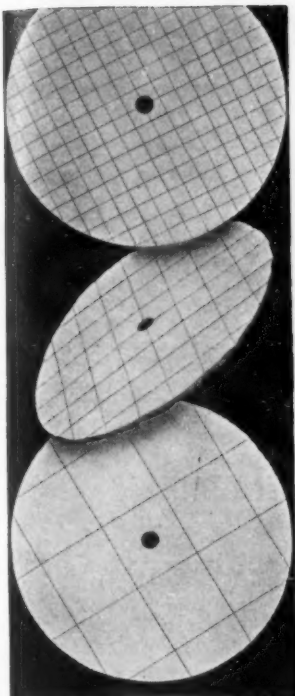
Write us about your metal cleaning problems.

MAGNUSON PRODUCTS CORPORATION

Main Office and Factory, Third & Hoyt Sts., Brooklyn, N. Y.

28 years' experience manufacturing, selling and servicing Specialized Industrial Cleaning Compounds for every purpose.

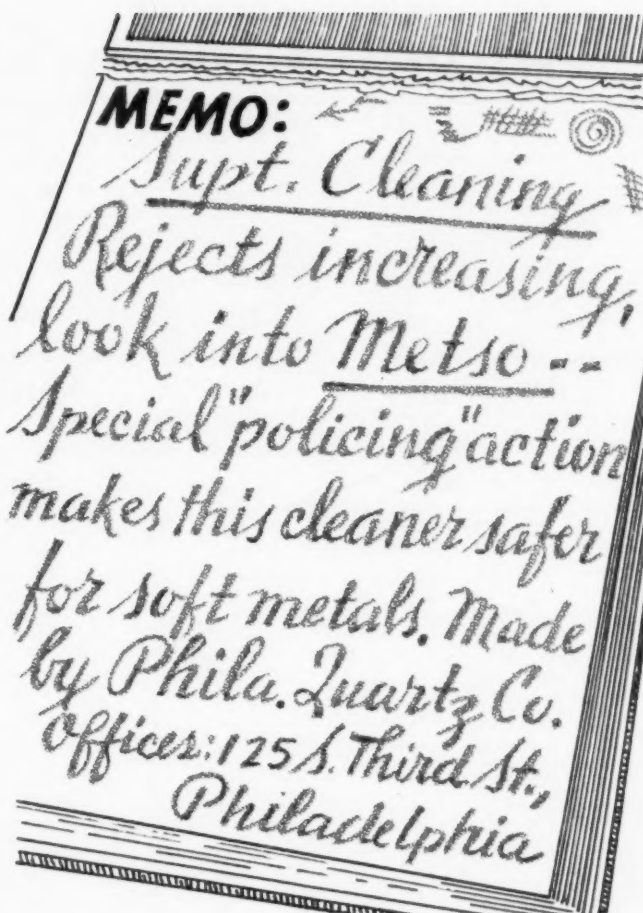
Representatives, also Warehouses in Principal Cities of United States
In Canada: Canadian Perm Mag Products Ltd., Montreal and Toronto



See How Much Money YOU Can Save . . .

PUT a Yerges buff to work on any job in your shop, from hardest, fastest cutting to softest buffing or polishing. See for yourself how much faster and better the Yerges buff does the work. Check the cost and see how much money the Yerges buff saves on that operation. The extraordinary performance and long life of the Yerges buff are the result of our exclusive bias-cut, square-stitched construction. The buff presents an absolutely uniform face to the work throughout its entire diameter. Made for every requirement. Ask for samples and data. The Yerges Mfg. Company, Fremont, Ohio.

YERGES



LIONITE POLISHING GRAINS

1. CBT LIONITE

An etched grain built to withstand the shock and stress of rough work. Sizes 10-90 incl.

2. EPT LIONITE

An etched grain designed to prevent glazing. For operations where little self-dressing of the wheel occurs. Sizes 24-90 incl.

3. ST LIONITE

A finishing grain. Chemically treated to facilitate "greasing". Sizes 100-240 incl.

THE
GENERAL ABRASIVE CO.

NIAGARA FALLS, N. Y.

Mines at

Berger, Ark.

Canadian plant at

Stamford, Ont.



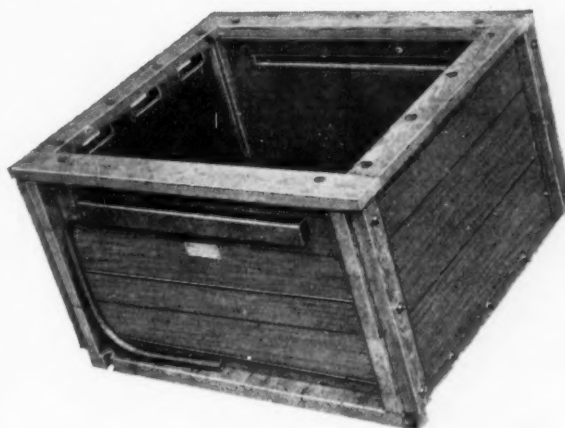
1869

1939

SEVENTY YEARS SERVICE

WOOD
TANKS

STEEL
TANKS



LEAD
LINING

RUBBER
LINING

THE HAUSER-STANDER TANK CO.
4838 SPRING GROVE AVE. CINCINNATI, OHIO

Supply Prices, October 30, 1939

Anodes

Prices, except silver, are per lb. f.o.b., shipping point, based on purchases of 2,000 lbs. or more, and subject to changes due to fluctuating metal markets.

COPPER: Cast	22 $\frac{3}{4}$ c. per lb.	NICKEL: 90-92%, 16" and over	.45 per lb.
Electrolytic, full size, 17 $\frac{3}{4}$ c.; cut to size	17 $\frac{3}{4}$ c. per lb.	95-97%, 16" " "	.46 per lb.
Rolled oval, straight, 17 $\frac{3}{4}$ c.; curved	18 $\frac{3}{4}$ c. per lb.	99%+cast, 16" and over, 47c.; rolled, depolarized, 16" and over, 48c.	
BRASS: Cast	20 $\frac{1}{4}$ c. per lb.	SILVER: Rolled silver anodes .999 fine were quoted from 49c. per Troy ounce upward, depending on quantity.	
ZINC: Cast	11 $\frac{1}{2}$ c. per lb.		

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P. l.c.l., drums	lb.	.06 $\frac{1}{4}$	Gum, Arabic, white, powder, bbls.	lb.	.125-14
Acid, Boric (boracic) granular, 99.5%, bbls.	lb.	.053-.059	Sandarac, prime, bags	lb.	.50
Chromic, 99%, 100 lb. and 400 lb. drums	lb.	.16 $\frac{1}{2}$ -.17 $\frac{1}{4}$	Hydrogen Peroxide, 100 volume, carboys	lb.	.20
Hydrochloric (muriatic) Tech., 20°, carboys	lb.	.027	Iron Sulphate (Copperas), bbls.	lb.	.016
Hydrochloric, C.P., 20°, carboys	lb.	.08	Lead, Acetate (Sugar of Lead), bbls.	lb.	.11-.13 $\frac{1}{2}$
Hydrofluoric, 30%, bbls.	lb.	.07-.08	Oxide (Litharge), bbls.	lb.	.125
Nitric, 36°, carboys	lb.	.06	Magnesium Sulphate (Epsom Salts), tech., bag	lb.	.018
Nitric, 42°, carboys	lb.	.075	Mercury Bichloride (Corrosive Sublimate)	lb.	\$1.58
Oleic (Red Oil), distilled, drums	lb.	.09-.10	Mercuric Oxide, red, powder, drums	lb.	\$2.66
Oxalic, bbls. l.c.l.	lb.	.12-.14	Nickel, Carbonate, dry, bbls.	lb.	.36-.41
Stearic, double pressed, distilled, bags	lb.	.12 $\frac{1}{2}$ -.13 $\frac{1}{2}$	Chloride, bbls.	lb.	.18-.22
single pressed, distilled, bags	lb.	.12-.13	Salts, single, 425 lb. bbls.	lb.	.135-.145
triple pressed, distilled, bags	lb.	.15 $\frac{1}{4}$ -.16 $\frac{1}{2}$	Salts, double, 425 lb. bbls.	lb.	.135-.145
Sulphuric, 66°, carboys	lb.	.025	Paraffin	lb.	.05-.06
Alcohol, Amyl, l.c.l., drums	lb.	.16-.175	Perchloroethylene, drums	lb.	.08 $\frac{1}{2}$
Butyl-normal, l.c.l., drums	lb.	.095	Phosphorus, red	lb.	.42
Denatured, S.D. No. 1, 190 pf., drms, works	gal.	.305-.335	yellow	lb.	.55
Diacetone, pure, drums, l.c.l.	lb.	.095	Potash, Caustic, 88-92%, flake, drums, works	lb.	.07 $\frac{1}{4}$ -.075
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.385-.405	Potassium, Bichromate, crystals, casks	lb.	.09 $\frac{1}{4}$
Propyl-Iso, 99%, l.c.l., drums	gal.	.41	Carbonate (potash) 98-100%, drums	lb.	.06 $\frac{1}{4}$
Propyl-Normal, drums	gal.	.70	Cyanide, 94-96%, cases	lb.	.525
Alum, ammonia, granular, bbls., works	lb.	.0315	Pumice, ground, bbls.	lb.	.03
Potash, granular, bbls., works	lb.	.034-.037	Quartz, powdered	ton	\$30.00
Ammonia, aqua, 26°, drums, carboys	lb.	.02 $\frac{1}{4}$ -.05 $\frac{1}{4}$	Quicksilver (Mercury) 76 lb. flasks	flask	\$90.00
Ammonium, chloride (sal-ammoniac), white, granular, bbls.	lb.	.05-.075	Rochelle Salts, crystals, bbls.	lb.	.21 $\frac{1}{4}$
Sulphate, tech., bbls.	lb.	.035-.05	Rosin, gum, bbls.	lb.	5.25-7.75
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55-.58	*Silver, Chloride, dry, 100 oz. lots	oz.	.32 $\frac{1}{4}$
Sulphocyanide (thiocyanate), com'l, drums	lb.	.16	Cyanide, 100 oz. lots	oz.	.35-.37 $\frac{1}{4}$
Antimony Chloride (butter of antimony), sol., carboys	lb.	.19 $\frac{1}{2}$	Nitrate, 100 oz. lots	oz.	.27 $\frac{1}{4}$
Barium Carbonate, ptd., l.c.l., bags, works	lb.	.03	Sodium, Carbonate (soda ash), 58%, bbls.	lb.	.0235
Benzene (Benzol), pure, drums, works	gal.	.21	Cyanide 96%, 100 lb. drums	lb.	.15
Butyl Lactate, drums	lb.	.225	Hydroxide (caustic soda) 76%, flake	lb.	.0355
Cadmium Oxide, l.c.l., bbls	lb.	.80	Hyposulphite, crystals, bbls.	lb.	.035-.065
Calcium Carbonate (Ptd. chalk), U.S.P.	lb.	.05 $\frac{1}{4}$ -.075	Metasilicate, granular, bbls.	lb.	.0315
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05 $\frac{1}{4}$ -.06	Nitrate, tech., bbls.	lb.	.029
Carbon Tetrachloride, l.c.l., drums	gal.	.73	Phosphate, tribasic, tech., bbls.	lb.	.027
Chrome, green, commercial, bbls.	lb.	.22	Pyrophosphate, anhydrous, bbls., l.c.l.	lb.	.0595
Chromic Sulphate, drums	lb.	.26 $\frac{1}{4}$	Sesquisilicate, drums	lb.	.0405
Cobalt Sulphate, drums	lb.	.59	*Stannate, drums	lb.	.36 $\frac{1}{2}$ -.38 $\frac{1}{2}$
*Copper, Acetate (verdigris), bbls.	lb.	.25	Sulphate (Glauber's Salts), crystals, bbls., works	lb.	.0135
Carbonate, 53/55%, bbls.	lb.	.17	Sulphocyanide, drums	lb.	.30-.35
Cyanide, Tech., 100 lb. bbls.	lb.	.34	Sulphur, Flowers, bbls., works	lb.	.037-.0410
Sulphate, Tech., crystals, bbls.	lb.	.05	*Tin Chloride, 100 lb. kegs	lb.	.41 $\frac{1}{2}$
Cream of Tartar (potassium bitartrate), crystals, kegs	lb.	.26 $\frac{1}{4}$	Toluene (Toluol), pure, drums, works	gal.	.27
Crocus Martis (iron oxide) red, tech., kegs	lb.	.07	Trichlorethylene, drums	lb.	.08 $\frac{1}{2}$
Dibutyl Phthalate, l.c.l., drums	lb.	.195	Tripoli, powdered	lb.	.03
Diethylene Glycol, l.c.l., drums, works	lb.	.155	Wax, Bees, white, bleached, slabs 500 lbs.	lb.	.40-.44
Dextrine, yellow, kegs	lb.	.05-.08	Bees, yellow, crude	lb.	.30-.32
Emery Flour (Turkish)	lb.	.07	Carnauba, refined, bags	lb.	.46-.50
Ethyl Acetate, 85%, l.c.l., drums	lb.	.075	Montan, bags	lb.	.25-.27
Ethylene Glycol, l.c.l., drums, works	lb.	.17-.20	Spermaceti, blocks	lb.	.26-.27
Flint, powdered	ton	30.00	Whiting, Bolted	lb.	.025-.06
Fluorspar No. 1 ground, 97-98%	ton	\$60.00	Xylene (Xylol), drums, works	gal.	.31
Fusel Oil, refined, drums	lb.	.125-.14	Zinc, carbonate, bbls.	lb.	.15-.17
*Gold, Chloride	oz.	\$18 $\frac{1}{4}$ -.23	Cyanide, 100 lb. kegs	lb.	.33
Cyanide, potassium 41%	oz.	\$15.45	Chloride, granular, drums	lb.	.06
Cyanide, sodium 46%	oz.	\$17.10	Sulphate, crystals, bbls.	lb.	.04

*Subject to fluctuations in metal prices.